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USSR Report

MATERIALS SCIENCE AND METALLURGY

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Non-Consumable Electrodes for Melting Highly Reactive Refractory Metals and Alloys
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ANALYSIS AND TESTING

UDC 621.745.43:669.131.6:620.191.33

STRUCTURE AND MECHANICAL PROPERTIES OF GRAY IRON

Moscow LITEYNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 6-7

[Article by R. G. Gvetadze, candidate of technical sciences, G. D. Mumladze, candidate of technical sciences, and U. S. Mikadze, candidate of technical sciences]

[Abstract] A method of monitoring the mechanical properties of gray iron ha been proposed (USSR Inventor's Certificate No 757,948) which does not require preliminary chemical analysis. As criterion of its mechanical properties one can use a structure-sensitive indicator, namely the stress building up when linear deformation is restrained during crystallization and cooling. The method is based on stress-time curves and their mathematical model. The relations describing the dependence of the critical stresses and the time periods on these curves on critical process temperatures are established by regression analysis of data on the basis of a 3^3-factorial experiment pertaining principally to the pearlite phase. The significance of only three factors and insignificance of others has been established by statistical analysis of physical experimental data characterizing the casting kinetics. The method was applied to pig iron produced at the Krivorozhstal' Metallurgical Combine.

2415/9835
CSO: 1842/90

UDC 669.851/.86:538.665

MAGNETOCALORIC EFFECT IN HEAVY RARE-EARTH METALS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 15 Jan 85) pp 689-694

[Article by S. A. Nikitin, A. S. Andreyenko, A. M. Tishin, A. M. Arkharov and A. A. Zherdev, Moscow State University imeni M. V. Lomonosov; Moscow Higher Technical School imeni N. E. Bauman]

[Abstract] A study of the magnetocaloric effect in magnetic rare-earth metals (Tb, Dy, Ho, Er, Tm) was made, including evaluation of the magnetic component of their change of entropy during magnetic phase transitions. In the experiment a magnetic field with an induction up to 6T was produced inside a superconducting solenoid with specimens of those metals were inserted into it very fast, within 0.1 s, from the zero-field outside region in a long furnace with a small longitudinal temperature gradient. A thermocouple was placed in the central portion of the specimen and the change of its emf occurring as the specimen reached the center of the solenoid was recorded as measure of the magnetocaloric effect. Specimens of polycrystalline Tb, Dy, Ho, Er, Tm and also of single crystal Tb, cut from ingots into 10 mm long cylinders having a diameter of 5 mm, were homogenized by annealing, their impurity content being held below 0.1% Sm, 0.1% Eu, 0.02% Ta, 0.01% Fe, 0.01% Cu, 0.01% Ca. The measured temperature dependence of the magnetocaloric effect in all these metals reveals a major peak within the 60-265 K temperature range near their respective antiferromagnetism-paramagnetism transition point. This correleates with the linear dependence of the magnetocaloric effect ΔT on the temperature derivative of the magnetization $\partial I/\partial T$ according to the relation

$$\Delta T = -\frac{T}{C_{p,H}}\left(\frac{\partial I}{\partial T}\right)H\,\Delta H$$

($C_{p,H}$- thermal capacity, ΔH- change of magnetic field intensity) and with the sign reversal $\frac{\partial I}{\partial T}$ from positive to negative as the magnetic induction exceeds the saturation level so that $\Delta T > 0$ when the magnetic field is applied and $\Delta T < 0$ when it is removed. Numerical evaluation of the data indicates a magnetocaloric effect of up to 10 K during switching of a magnetic field with an induction of approximately 6 T at the phase transition temperature. The maximum attainable magnetocaloric effect has been estimated on this basis according to the thermodynamic relations for the magnetic part of change of entropy $\Delta S_M = \frac{\Delta T}{T} C_{p,0}$ and $S_M^{max} = R \log(2J + 1)$ (R- universal gas constant, J-quantum number), while the temperature dependence of the thermal capacity in a magnetic field has been determined from the thermodynamic relation $C_{p,H} = T\left(\frac{\partial S}{\partial T}\right)_{p,H}$. References 13: 10 Russian, 3 Western (1 in Russian translation).

2415/9835
CSO: 1842/94

UDC 669.234'872:535.33/.34

STRAIN DEPENDENCE OF ELECTRONIC STRUCTURE AND OPTICAL ABSORPTION IN PdIn INTERMETALLIC COMPOUND

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 1 Feb 85) pp 712-171

[Article by A. B. Shaykin, M. M. Kirillova and A. V. Zvezdin, Metal Physics Institute, Ural Science Center, USSR Academy of Sciences]

[Abstract] In original study of the equiatomic intermetallic PdIn compound and its piezooptical reflection spectrum was made for the purpose of determining the dependence of its energy band structure and optical interband conductivity on the elastic strains as well as for determining the deformation potentials corresponding to threshold quantum absorption. Specimens with various orientations were cut from one single crystal with a temperature dependence of electrical resistivity corresponding to a ratio $\rho_{295K}/\rho_{4.2K} = 7$ and with class-14 mirror surfaces produced by electrical polishing in an HCl + $HClO_4$ solution. Measurements of their piezooptical reflection spectra in polarized light were made over the 1-4.9 eV energy range while uniaxial stresses were induced by cyclic bending at a frequency of approximately 400 Hz. The deflection of their mirror surfaces was measured, accurately within 10%, with a normally incident light beam from an LG-78 neodymium-glass laser. Components of the piezooptical reflection tensor have been calculated from these data, considering that a PdIn crystal is a cubic one belonging in the m3m group with a reflection tensor Q determined by its three components Q_{1111}, Q_{1122}, Q_{2323} and that any strain in it can be represented as the sum cubic, tetragonal, and trigonal basis strains. Components of the optical conductivity tensor have been subsequently calculated with the aid of the Kramers-Kronig transformation. The results indicate that the change in optical intraband conductivity is maximum within the 2.1-2.6 eV range of the "main" absorption threshold, where electron transitions occur in the Σ-direction of the Brillouin zone so that the energy gap decreases from $\Sigma_4(E_F)$ to Σ_1. They also indicate that the deformation potentials of energy bands with s and p symmetry are much higher than those of d-bands. The authors thank N. V. Gorin for supplying a PdIn single crystal and V. V. Gudkov for measuring the ultrasound velocity. References 10: 1 Russian, 9 Western.

2415/9835
CSO: 1842/94

UDC 669.28+669.293:669.786

PARAMETERS OF NITRIDING KINETICS OF NIOBIUM ALLOYS AND MOLYBDENUM ALLOY WITH VARIOUS STRUCTURES

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 27 Mar 84, in final version 18 Dec 84) pp 776-779

[Article by G. A. Solodkin, A. A. Bulgach and T. Ye. Likhacheva, Moscow Automobile Highways Institute]

[Abstract] Nitriding of two niobium alloys (VN-2AE, VN-3) and one molybdenum alloy doped with hafnium (Mo + 0.2 wt.% Hf) was studied, the purpose being to determine the effect of prior plastic deformation on the nitriding process kinetics. The niobium alloys were cold rolled and the molybdenum alloy was hot rolled at 1100°C to 1 mm thick strips through 25-50-75-90% reduction steps, whereupon 15 mm long and 5 mm wide specimens were cut for further treatment. Some of them were annealed under a vacuum of $1.13 \cdot 10^{-3}$ Pa, the niobium alloys at 1350°C for 2 h and the molybdenum alloy at 1500°C for 30 min. All were nitridied at 900-1000-1100-1200°C for 1-3-6 h, the niobium alloys with extra-pure nitrogen and the molybdenum alloy with ammonia. Both nitriding gases had been passed through silica gel and titanium sponge for removal of any water vapor and oxygen. Microstructural and metallographic examination of nitrided specimens after etching revealed an unetchable white strip of nitrides on the surface and a layer of internal nitriding underneath. The thickness of the nitride zone was measured with a PMT-3 microhardness tester under a 50 g load. The thickness of the internal nitriding zone was measured as the depth below the nitride strip at which the hardness had dropped to 2100 MPa and thus to only 500 MPa above the 1600-1700 MPa hardness of the core metal. The hardness of that internal nitriding layer at its upper boundary, with the nitride strip, was found to vary over the 5000-9000 MPa range depending on the nitriding temperature. An evaluation of the gravimetric and hardness data has yielded a relation between the thicknesses of both zones and the degree of plastic deformation by rolling, the thickness of the nitride layer being minimum and the thickness of the internal nitriding layer being maximum after 25% reduction in the molybdenum alloy and in the VN-2AE niobium alloy and after 50% reduction in the VN-3 nibbium alloy. The thicknesses y_1 and y_2 of the two layers were both found to be parabolic functions of time $y^2 = Kt$, with the nitriding rate constant K closely obeying the Arrhenius law $K = K_0 e^{-Q/RT}$. The parameters of nitriding kinetics, namely activation energy Q and initial rate K_0 depend analogously on the percentage reduction (plastic deformation). References 7: all Russian.

2415/9835
CSO: 1842/94

UDC 669.234'25:539.216.2:537.311.31

STRUCTURAL TRANSFORMATION IN FILMS OF Co-Pd ALLOY DEPENDING ON TEMPERATURE OF SUBSTRATE DURING CONDENSATION

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received, in final version, 7 Dec 84) pp 824-827

[Article by Ye. M. Artemyev, A. S. Komalov and A. A. Smyk, Physics Institute imeni L. V. Kirenskiy, Siberian Department, USSR Academy of Sciences]

[Abstract] An experimental study of $Co_{1-x}Pd_x$ films with x ranging from 0.1 to 0.8 was made for the purpose of refining the phase diagram of this alloy system and pinpointing the previously discovered phase existing in nearly equiatomic Co-Pd films on substrates at temperatures up to 190°C. Specimens of such films 20-150 nm thick were dposited by vacuum condensation under a residual pressure of $1.33 \cdot 10^{-3}$ Pa on glass, quartz, MgO, LiF substrates at temperatures ranging from -150°C to 250°C. Film thickness and composition were monitored by x-ray fluorescence analysis. The structure of these films was examined under a UEVM-100K electron microscope, in a DRON-2 x-ray diffractometer, and with an EMP-100 electron diffractograph. Their magnetic properties, namely saturation magnetization and coercive force, were measured by the torque method and with a hysteresimeter. The temperature dependence of their electrical resistance was determined with the temperature rising at a rate of 2.5°C/min. The results confirm the existence of a c.p.h. phase in films with 40-100% Co. Lowering the condensation temperature facilitates its formation without inhibiting diffusion of its nuclei, while raising the condensation temperature stimulates buildup of the f.c.c. phase. References 3: 1 Russian, 2 Western (1 in Russian translation).

2415/9835
CSO: 1842/94

UDC 669.296'293:620.186.1

STRUCTURE AND PHASE COMPOSITION OF Zr + 2.5% Nb ALLOY RAPIDLY COOLED FROM β-PHASE RANGE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 20 Jan 84, in final version 25 Dec 84) pp 827-829

[Article by V. N. Shenyakin and G. D. Baynova]

[Abstract] A study of the industrial Zr + 2.5% Nb alloy was made, for determination of its structure and phase content after heating in air to 1000°C and subsequent cooling in air or water at rates of 3, 30, 60, 120, 150 °C/s. Heating and cooling curves were recorded with a KSP-4 high-speed potentiometer and on an NO04 M1 light-beam oscillograph. After removal of the surface oxide film and at least 5 mm of metal underneath, structural examination was performed under an MIM-8M optical microscope, under a UEMV-100K electron microscope, and in a DRON-1.5 x-ray diffractometer with a CuK_{α} source. To serve as reference standard, a specimen of this alloy was annealed at 750°C under vacuum for 2 h and then cooled at a rate of 100°C/h. The results reveal a temperature lag during cooling at the slower rates, this lag diminishing and shifting toward lower temperatures as the cooling rate increases. Cooling at the slower rates of 3-60 °C/s produces both α-Zr and β-Zr phases, the latter disappearing as the cooling rate increases. The α-phase exists in several forms, appearing in pinnate and lenticular form near grain boundaries of the β-phase during slow cooling, then appearing in pinnate form only and at the grain boundaries of the β-phase only during faster cooling, and finally appearing in acicular form filling the space of grains of the vanished β-phase during very fast cooling. This trend is an indicator of displacement rransformation into the so-called α '-phase. The lattice parameters of this phase begin to increase after 30 h of tempering at 500°C, indicating its breakup with attendant formation of β-Nb. The authors thank L. P. Sinel'nikov for helpful discussion. References 3: 1 Russian, 2 Western.

2415/9835
CSO: 1842/94

UDC 621.724

INTER-PHASE INTERACTION AND MASS TRANSFER OF COMPONENTS IN Al_2O_3-TiN SYSTEM DURING SINTERING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 24 Jun 84) pp 32-38

[Article by Ye. D. Mnatsakanyan, Yu. N. Vil'k, Yu. N. Paputskiy, L. V. Kozlovskiy and S. S. Ordan'yan, Leningrad Polytechnical Institute]

[Abstract] Among cutting instrument materials, mineral-ceramic combinations are of special interest. The present article reports on features of mass transfer and interaction between components of a system containing aluminum oxide and ultra-dispersed titanium nitride at high temperatures in a vacuum, in nitrogen, as well as during hot pressing in graphite forms. Cylindrical specimens with 10 mm diameter and 12 mm height were sintered in pure nitrogen in a resistance furnace at 1600-2400 K for 1 hour. Then the Al_2O_3-TiN powders were analyzed with a diffractometer. Results indicated an increased level of microdeformation or possible dissolution of carbon and oxygen due to dissociative evaporation of Al_2O_3. X-ray analysis indicated that no significant interaction in the system at temperatures below 2400 K. Results of hot pressing suggested that density was not closely reated to the duration of isothermal treatment. In a vacuum at 1600-1800 K, and in nitrogen, sintering brought compaction of the specimens, amounting to 17-18% at 1800 K, but sintering also caused weight loss in the Al_2O_3-TiN specimens. The system continued to contain two phases up to 2300 K. Oxidation, which occurred in both components, depended on the method and procedures of thermal processing. References 9: 7 Russian, 2 Western (1 in Russian translation).

12131/9835
CSO: 1842/101

UDC 621.762:669.018

NATURE OF LIQUID PHASE FORMED DURING SINTERING OF R6M5 STEEL PRODUCED FROM METAL SHAVINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 19 Nov 84) pp 42-44

[Article by V. S. Panov, Yu. F. Kots and V. I. Bodnarchuk, Moscow Steel and Alloys Institute]

[Abstract] Powder metallurgy has been used to produce numerous high-speed cutting steels, but little attention has been devoted to the liquid phase of such metals. The present article reports on a study of the conditions of liquid phase appearance during sintering of R6M5 steel in a temperature range of 20-1300°C. The composition of the steel was determined

by thermogravimetry and electron microscopy. The need to use a two-stage sintering process was substantiated; the first, low-temperature, stage to promote as complete as possible reduction of oxides so as to prevent formation of a liquid phase; the second, final, sintering at above 1200°C to produce practically poreless specimens. Increasing the temperature of initial liquid phase formation by 5-10°C brought significant accumulation of hydroxycarbide eutectics at granular boundaries and contact points. Two-stage sintering was regarded as essential for producing poreless metal of high quality. References 3: all Russian.

12131/9835
CSO: 1842/101

UDC 669.01:539.216:661:669.018.4

ORDERING IN NIOBIUM MONOCARBIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 15 Mar 85) pp 53-59

[Article by B. V. Khayenko and O. P. Sivak, Institute of Material Science Problems, UkSSR Academy of Sciences, Kiev]

[Abstract] Ordering in niobium monocarbide with defective carbon has been shown to take place in a range of $NbC_{0.7}$-$NbC_{0.95}$ at temperatures below 1173 K. The present article attempts, based on additional information obtained by X-ray study of crystallites isolated from ingots and other supplemental data, to summarize the data concerning ordering in niobium monocarbide. Various cooling and tempering procedures, including tempering at 1200-1500 K in liquid gallium, were used. Data show that the compositions and forms of thermal processing that typify specific groups of reflections limit the clear diffraction picture of superstructural reflexes and must be regarded as signs of close-range order. Other features characterize an area of long-range order. All of the observed orders, however, were regarded to be within the nominal range of homogeneity for niobium monocarbide. The Debayev method was used to fix an additional superstructural reflection. The redistribution of carbon atoms in the δ-phase zone between planes of the crystalline structure formed a normally ordered structure in δ'-NbC_x. Thus a balanced structure with clear superstructural reflections along fluid curves was suggested, although direct proof of this structure was not obtained. References 10: 8 Russian, 2 Western.

12131/9835
CSO: 1842/101

UDC 539.3

BENDING OF MULTILAYER ORTHOTROPIC SECTORIAL PLATES

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 85
(manuscript received 28 Nov 83) pp 49-52

[Article by A. G. Bondar' and A. O. Rasskazov, Kiev Automobile Highways Institute]

[Abstract] A finite-shear theory is used to study symmetrical multilayer sectorial plates in the form of a circular segment. Realization of the resolution system of differential equations in partial derivatives is accomplished with the aid of a numerical method that relys on the joint use of integrating and differentiating matrices. This permitted modeling of various border conditions and examination of loads distributed according to various laws on various edges, circumferential or radial, of a plate. The bending of three-, five- and seven-layer plates under an equally distributed load was examined. All these plates had an equal total amount of material in the load-bearing layers and in the filler. Calculation results indicated that in all the variations of border conditions examined a change in the structure of the stack significantly influenced the stressed state of the plates. References 6: all Russian.

12131/9835
CSO: 1842/102

UDC 620.1:539.434

STUDY OF EFFECTIVENESS OF PROTECTIVE COATINGS ON ZhS6U ALLOY DURING THERMAL FATIGUE

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 85
(manuscript received 10 Nov 84) pp 52-57

[Article by K. P. Buyskikh, Strength Problems Institute, UkSSR Academy of Sciences]

[Abstract] Reliable and efficient use of protective coatings to increase the load-bearing capacity of gas turbine vanes has been hindered by the lack of study of the influence of various factors, the effect of transient thermal loads being the most important. The article examines the influence of these factors in connection with an investigation of the load-bearing capacity of the alloy ZhS6U with protective coatings in a gas flow under thermocyclical load. The method provided comparative data on the thermocyclical durability of three standard sizes of wedge-shaped specimens of the alloy with and without coatings. Three sequentially connected test chambers were used for the experiment in each of which specimens of a single size were mounted in a gas flow in order to obtain a specific level of

temperatures and thermal stresses on the edges of the specimens in each of the sections. The thermocyclical durability of a part with coating was studied in relation to the level of the thermally stressed state of an unprotected specimen of a specific size and the influence of a specific protective coating. Tests were conducted in two stages, each based on ZhS6U alloys cast from two different melts. The technological processes, including heat treatment and coating application, were identical in both cases. The coatings studied were divided into two groups depending on the method of application. Thermocyclical durability was evaluated on the basis of crack formation. Analysis of the behavior of the failure of wedge-shaped specimens with protective coatings under thermocyclical loading in a high-temperature gas flow indicate than an unequivocal ranking of coatings on the basis of thermal fatigue is impossible. Depending on the temperatures and the thermal stresses, as well as the application technology, the effect of increasing the thermocyclical durability due to application of a coating is different for different coatings. References 4: all Russian.

12131/9835
CSO: 1842/102

UDC 539.370:539.16.04

EFFECT OF TEMPERATURE ON MECHANICAL CHARACTERISTICS OF COLD-SHAPED OKh16N15M3B STEEL UNDER ACTIVE TENSION AND CREEP

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 85
(manuscript received 21 Nov 83) pp 70-73

[Article by V. S. Yerasov, Ye. N. Pirogov and V. P. Konoplenko, Moscow, Engineering Physics Institute]

[Abstract] Jackets of heat-emitting components of atomic reactors are often made of OKh16N15M3B steel which has been heated to 1323-1373 K, held at the maximum temperature for 30 minutes and, then air or water cooled. The present article reports on a study of the mechanical characteristics of cold-shaped steels, deformed by 20% under active tension and creep at temperatures of 973-1323 K. These characteristics are needed for predicting the behavior of the jackets in accident situations. Samples were tested at various temperatures in the given range. Results showed that at 973 K cold shaping brought an increase of 2.5 times in the yield point and a reduction of ductibility of almost 4 times with practically constant ultimate strength; with an increase in temperature from 973 to 1223 K strength properties decreased in a quasi-linear fashion. The slower the deformation rate the more intense was the decrease in the yield point and ultimate strength values. Above 1223 K, strength characteristics decrease at a slower rate. Short-term creep was studied in the range of 30 to 420 MPa applied pressure and the empirical dependencies of the creep rate on stress and temperature determined. References 14: 13 Russian, 1 Western (in Russian translation).

12131/9835
CSO: 1842/102

UDC 669.3'71:539.67

AMPLITUDE DEPENDENCY OF DAMPING CAPABILITY OF Cu-Al-Zn-Cd SYSTEM ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 85
(manuscript received 21 Nov 84) pp 78-81

[Article by O. G. Zotov, S. Yu. Kondrat'yev, G. Ya. Yaroslavskiy, B. S. Chaykovskiy and V. V. Matveyev, Kirovskiy Zavod Production Association, Leningrad; Strength Problems Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] Systematic study of the effect of alloying by elements forming with copper constitution diagrams with a β-phase that undergoes reverse martensite conversion during quenching on the physicomechanical properties of damping Cu-Al alloys has shown the best combination of properties is achieved in alloys of the Cu-Al-Zn system. The present article reports on attempt to increase the damping properties of such alloys by adding cadmium, which is practically insoluble in copper and forms various chemical compounds with it. The influence of cadmium on the amplitude dependencies of the logarithmic decrement of oscillations and their microstructure were examined. Alloys of the Cu-Al-Zn-Cd system containing by mass 7.0% Al, 6.6-16.0% Zn, 0 or 1% Cd and the remainder copper were studied. After smelting heat treatment consisted of diffusion annealing at 500°C 24 hours, and quenching from 700°C in water with holding at the quenching temperature for 3 hours. Results showed that alloying by cadmium significantly influences the morphology of marteniste but does not change the quantitative relationship of the α and martensite phases in the structure of quenched (α and β) alloys of the Cu-Al-Zn system, thus increasing damping capability. The highest damping capability was found with alloys containing about 40% martensite and 1% cadmium (by mass). References 7: all Russian.

12131/9835
CSO: 1842/102

UDC: 658.382.3:669.014.85

PARAMETERS OF EXPLOSION OF FERROMANGANESE POWDER IN THE PRESENCE OF FLAMMABLE GAS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 20 Mar 85) p 133

[Article by I. V. Babaytsev, M. S. Popov and A. K. Toleshov, Moscow Steel and Alloys Institute]

[Abstract] Theppurpose of this work was to determine the influence of flammable gas on the ignition of ferromanganese powder. Experiments were performed in a chamber containing a mixture of propane and air with a concentration of 3 to 4% C_3H_8. The presence of the powder increases the maximum pressure of an explosion by a factor of 2 and significantly increases the pressure rise rate. Increasing the propane concentration by 1% increases the maximum dust-gas-air mixture explosion pressure by a factor of 2 and the pressure rise rate by a factor of 4.5. The powder was thus demonstrated to have an active role in the explosion of the trinary system. References 1: Russian.

6508/9835
CSO: 1842/106

UDC: 621.774.5

DISTRIBUTION OF ALLOYING ELEMENTS THROUGH THE THICKNESS OF THE WALL OF CENTRIFUGALLY CAST BIMETALLIC PIPE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 18 Jan 85) pp 133-134

[Article by Yu. G. Gulyayev, M. Z. Volodarskiy and N. E. Netsetskaya, Dnepropetrovsk Metallurgical Institute; All-Union Scientific-Research and Design-Technological Institute of the Pipe Industry]

[Abstract] Centrifugally cast bimetallic pipe has nonuniform distribution of alloy elements through the wall thickness, determined primarily by the different content of the elements in the materials of each of the layers cast, diffusion of the elements between layers and the specific nature of the crystallization of metals as the casting thins. A mathematical model is obtained for the distribution of alloying elements in such pipe. A figure compares calculated and experimental data on the distribution of alloying elements in bimetallic centrifugally cast pipe for use in the chemical industry.

6508/9835
CSO: 1842/106

UDC: 669.018.5--131.2--157.96:620.162.2

SUPERPLASTICITY OF THE ALLOY Fe-23% Cr-15% Co-1% Ti FOR PERMANENT MAGNETS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 5 Jun 85) pp 137-138

[Article by R. Z. Valiyev, A. V. Korznikov and V. V. Stolyarov, Ufa Aviation Institute]

[Abstract] The alloy KH23K15T is a promising material for the manufacture of permanent magnets, but does not have sufficient ductility for the manufacture of complex-shaped products. A fine-grained structure was obtained by cold rolling with 70% deformation after hardening and subsequent recrystallization annealing at 900°C for 5 minutes. It was found that reducing grain size from 300 μm to 1 μm increases the ductility of the alloy from 90% to 600% at 900°C with a deformation rate of $1.6 \cdot 10^{-3}$ s^{-1}.

6508/9835
CSO: 1842/106

UDC: 669.018.29:621.181

KINETICS OF AUSTENITE CONVERSION IN POWDERED STEEL TYPE ZhGr1D3 BEFORE AND AFTER TREATING WITH COPPER

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 21 Mar 85) pp 139-140

[Article by Yu. G. Guryevich, A. G. Ivashko and I. F. Panshin, Kurgan Machine Building Institute]

[Abstract] A study is made of the kinetics of austenite conversion upon continuous cooling and thermokinetic diagrams are formulated for ZhGr1D3 steel with 17% porosity and for nonporous steel after treatment with liquid copper. Magnetometric studies were performed on specimens measuring 2x10x55 mm heated in purified argon to 870°C with a holding time of 2 minutes and then cooled at various speeds. Elimination of the porosity of ZhGr1D3 steel due to treatment with liquid copper significantly increases the resistance of the super cooled austenite and decreases the quantity of diffusion conversion products present. This is confirmed by an increase in hardness of the specimens after cooling at the identical rate. Reference 1: Russian.

6508/9835
CSO: 1842/106

UDC: [546.47+546.48+546.24]:543.253

INVERSION-VOLT-AMPERE DETERMINATION OF CONTENT OF TRACE QUANTITIES OF ALLOYING COMPONENTS (TELLURIUM, ZINC AND CADMIUM) IN SMALL SAMPLES OF INDIUM ANTIMONIDE CRYSTALS

Moscow AZVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85 (manuscript received 13 Feb 85) pp 14-16

[Article by A. A. Kaplin, V. M. Pichugina and N. M. Svishchenko, Tomsk Polytechnical Institute imeni S. M. Kirov]

[Abstract] A study was performed to develop methods of determining Zn, Cd and Te in microscopic specimens of indium antimonide crystals alloyed with these elements of polarographic studies. The disturbing influence of the major components of the specimen on analytic characteristics of the anode peaks of Te, Zn and Cd was studied. The hindering influence of indium can be eliminated by selecting electrolysis potentials and the background electrolyte. References 6: 5 Russian, 1 Western.

6508/9835
CSO: 1842/107

TURBIDIMETRIC DETERMINATION OF MICROSCOPIC QUANTITIES OF CESIUM IN THE PRESENCE OF SODIUM AND RARE EARTH ELEMENTS

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85 pp 22

[Article by T. M. Kochetkova and N. I. Siligina, All-Union Scientific Research Institute of Light Sources imeni A. N. Ladygin, Saransk]

[Abstract] The precipitated form selected for turbidimetric analysis of cesium was cesium phosphoromolybdate $Cs_3[P(Mo_3O_{10})_4]\cdot nH_2O$, the least soluble salt. The reagent was a saturated solution of phosphoromolybdic acid in water. A calibration graph is presented for turbidimetric determination of cesium in the solution.

6508/9835
CSO: 1842/107

UDC: 546.92:543.42

LASER PHOTOIONIZATION DETERMINATION OF PLATINUM METALS WITH ASSAY CONCENTRATION

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85 (manuscript received 2 Jul 84) pp 31-35

[Article by G. I. Bekov, V. N. Radayev, A. N. Kurskiy, E. P. Zdorova and Yu. B. Makarov, Spectroscopy Institute, USSR Academy of Sciences, Troitsk, Moscow Oblast]

[Abstract] A method of laser photoionization in combination with assay concentration and direct atomization of the collector in a graphite furnace under a vacuum has been suggested for analysis of ores, sedimentary and igneous rock, sea water and vegetable matter for traces of ruthenium. The spectrometer was calibrated using standard specimens of alloys of copper with the noble metals with varying contents of ruthenium. The relative standard deviation for a single measurement due to the instrumental error of the method of laser photoionization analysis is 0.06. The uniformity of distribution of ruthenium in copper buttons was studied by the method. Collection in a copper alloy can be recommended for analysis of objects with 0.1-1 g/t of platinum metals. Collection in a lead alloy allows greater enrichment factors and is more promising for specimens with very low ruthenium content. This method was used to measure the ruthenium content in a broad class of marine specimens, including sea water, underwater plants, silicon-containing sediment, and various iron-manganese nodules. References 9: 8 Russian, 1 Western (in Russian translation).

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UDC: 543.422

ATOMIC ABSORPTION DETERMINATION OF LEAD AND CADMIUM IMPURITIES IN NONFERROUS METALS AND THEIR ALLOYS BY MEANS OF A GRAPHITE ATOMIZER

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85 (manuscript received 26 Nov 84) pp 35-37

[Article by A. N. Zakhariya, T. M. Shcherbakova and G. O. Taylakova, Odessa State University imeni I. I. Mechnikov]

[Abstract] A simple, reliable and rapid method has been developed for determining Pb and Cd impurities of at least $3.0 \cdot 10^{-4}$% in certain nonferrous metals and alloys using a graphite rod electrothermal atomizer in air. The lower and upper limits of the Pb and Cd concentration being determined were established under optimized conditions, as were the corresponding intervals

of relative standard deviation values. One determination requires not over 10-20 minutes. References 10: 9 Russian, 1 Western.

6508/9835
CSO: 1842/107

UDC: 669.35'6:669.35'5:546.47:543.422

ATOMIC ABSORPTION DETERMINATION OF ZINC IN BRONZE AND BRASS

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85 (manuscript received 3 May 84) pp 37-39

[Article by I. V. Pyatnitskiy, Ya. S. Pilipyuk, V. B. Ishchenko and V. V. Soloshonok, Kiev State University imeni T. G. Shevchenko]

[Abstract] The purpose of this work was to determine the influence of accompanying elements on atomic abosprtion determination of zinc with a flammable propane-butane-air mixture on a spectrophotometer and to develop methods for determining zinc in copper-based alloys. In determining small concentrations of zinc, the analytic signal $A=\log(I_0/I)$ was measured at the resonant 213.8 nm line. For greater concentrations of zinc the 307.6 nm line was used. The use of the latter line avoids the need for great dilution of the solution being analyzed. Optimal parameters for the determination are presented. The influence of the conditions of dissolution of the specimens and of the content of zinc in the solutions analyzed was studied, as well as the influence of excess quantities of copper, aluminum and tin on the absorption of zinc. The results indicate that under optimal conditions, the flammable air mixture is suitable for atomic absorption determination of zinc in solutions with aluminum, tin, and copper content of up to 10, 20 and 90% respectively. References 6: 4 Russian, 2 Western (1 in Russian translation).

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SPECTRAL DETERMINATION OF BISMUTH AND TIN IN TUNGSTEN CONCENTRATES

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85 pp 45-46

[Article by Z. S. Septar, G. A. Nedugova and M. D. Koyfman, Sredazniprotsvetmet, Almalyk]

[Abstract] A spectral method is suggested for determining tin and bismuth in tungsten concentrates. In comparison to chemical methods, the spectral method is simpler, less expensive, and faster, and does not require the use of expensive reagents to dissolve specimens. Bismuth and tin concentrations of 0.001-0.01% can be determined.

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UDC: 546.5:543.53

DETERMINATION OF GOLD FROM EXCITATION OF ISOMER STATE IN RADIAL CHANNEL OF VVR-SM NUCLEAR REACTOR

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85
(manuscript received 8 Oct 84) pp 56-59

[Article by M. M. Usmanova, Z. Yen, Kh. Idrisov and Yu. F. Simakhin, Nuclear Physics Institute, Uzbek SSR Academy of Sciences, Tashkent]

[Abstract] A precision method is suggested for determining high contents of gold in specimens of a fixed diameter but different thicknesses, atomic masses and densities, with specimen mass up to 120 g, such as in pressed tablets. The method is based on excitation of the isomer state of the gold by the reaction (n,n') by fast neutrons with exposure in a radial reactor channel and measurement of the intensity of the gamma line of the isomer ^{197m}Au. The mass of the gold is determined by comparison of the intensity of this line in the specimen and in a comparison sample. For the measurement geometry suggested (density of the material of the specimen up to $8 \cdot 10^3 kg/m^3$, distance from specimen to detector 12 mm) the limit of detection, based on the criterion of a relative standard deviation of 0.33, is 2.3 mg, with neutron flux density in the reactor spectrum with energy over 1 MeV of $3.7 \cdot 10^8$ neutrons per square centimeter per second. The relative standard deviation with gold content over 500 mg is not over 0.015, linearly increasing with decreasing gold content. References 7: 5 Russian, 2 Western.

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UDC: 548.73

DETERMINATION OF ORIENTATION OF SINGLE CRYSTALS

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85
(manuscript received 3 Dec 84) pp 61-63

[Article by V. I. Matorin and M. M. Borodkina, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin, Moscow]

[Abstract] Grids are suggested which facilitate determination of the orientation of a single crystal from an epigram. The grids are drawn in arbitrary scale and allow practically any orientation of base-centered or body-centered cubic crystal to be determined without the cumbersome process of constructing a gnomostereographic projection. By using the grids and the methods of indicating reflection on an epigram described in the article it is possible to determine practically any orientation of a cubic crystal without construction of the gnomostereographic projection.

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ORIENTATION OF SINGLE CRYSTAL PLATES OF ARBITRARY SHAPE AND SIZE

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85
(manuscript received 6 Jul 84) pp 63-64

[Article by I. S. Gavrilenko, Yu. V. Titenko and S. S. Usenko]

[Abstract] A method is suggested for determining the disorientation of the surface of a single crystal with a crystallographic plane, based on the fact that the intensity of the diffraction maximum is determined by the contribution not only of crystals strictly oriented in accordance with the expression $2d \sin \theta = n\lambda$, but also those which are disoriented with respect to the plane by a certain angle determined by the focal length of the x-ray tube and the slit height. The method can be used to determine the angle of disorientation of the surface of a plate of aribtrary shape and size with a general purpose x-ray diffractometer with no design changes to the hardware, can can be used for operational and finish testing during cutting and grinding of single crystalsmaterials. References 3: all Russian.

6508/9835
CSO: 1842/107

UDC: [546.91+546.59]:543.425

ATOMIC ABSORPTION DETERMINATION OF PLATINUM METALS AND GOLD AFTER PRECIPITATION CONCENTRATION OF COPPER SULFIDE

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85
(manuscript received 1 Aug 84) pp 91-93

[Article by M. L. Rakhlina, M. Yu. Lomteva and G. I. Yermolina, Severonikel Combine, Monchegorsk]

[Abstract] A spectral method is used in the central plant laboratory to analyze technological products for content of platinum metals and gold. Precipitation concentration is first performed on copper sulfide, which is then heated to produce the oxide and the analytic concentrate thus produced is analyzed. However, the spectral method requires a pure analytic concentrate and identical comparison specimens. Atomic-absorption analysis, with the proper selection of buffer additives, can exclude both the influence of secondary components on the determination of platinum metals and their mutual influence. Studies have established that the influence of copper and cadmium is practically constant in the range of interest, allowing a copper-cadmium buffer to be used. An analysis solution can be produced for atomic absorption determination of platinum metals by direct dissolution of copper sulfide, eliminating the operation of thermal oxidation. This allows analysis by two independent methods, atomic

absorption and spectroscopy. This increases the reliability of the results of determination.

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UDC: 669.71:543.51

SPECTROGRAPHIC METHOD OF DETERMINING THE CHEMICAL COMPOSITION OF ALUMINUM ALLOYS

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 11, Nov 85 (manuscript received 19 Oct 84) p 93

[Article by M. I. Yurovitskaya and T. M. Kovaleva, Tsentrolit Foundry, Gomel]

[Abstract] A spectrographic method is suggested for determining the composition of aluminum alloys, permitting an increase in the accuracy of the determination of the components and mixtures while reducing analysis time by a factor of 25 and saving chemical reagents. The following analytic pairs of lines are used: Fe 259.94--Al 265.25; Si 288--Al 265.25; Mg 285.21--Al 265.25; Mn 259.37--Al 265.25; Cu 327.40--Al 305.01; Zn 334.50--Al 305.01. The time required to analyze one specimen and determine all elements contained is 30 minutes. Relative error is 8-10%.

6508/9835
CSO: 1842/107

UDC 669.187.2:669.85/.96

STUDY OF STRUCTURE OF MEDIUM ALLOY Cr-Ni-Mo STEEL SUBJECTED TO ELECTROSLAG REFINING USING RARE EARTH METALS AS FLUX COMPONENTS

Kiev PROBLEMY SPETSIAL'NOY ELEKTROMETALLURGII in Russian No 4, Oct-Nov-Dec 85 (manuscript received 4 May 83) pp 10-14

[Article by V. A. Tikhonov, B. I. Medovar, L. I. Markashova, T. S. Zarivayskaya, N. V. Zhuk and V. Ya. Sayenko, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] One approach to further improving structural steels produced by electroslag refining is the use of rare-earth metal compounds as flux components. The present article reports on a series of investigations of medium-alloy Cr-Ni-Mo steel method using industrial fluxes and fluxes containing rare-earth metal oxides. Using a television microscope and the method of electron microscopy nonmetallic inclusions were investigated over a broad

range of sizes. The investigation showed that, depending on the flux used, the quantity and character of distribution of inclusions by size groups fluctuated in varying degree. The metallographic and electron microscope studies conducted led to a number of conclusions. As the content of rare-earth metal oxides in the flux increased the total number of non-metallic inclusions in the electroslag metal decreased and their degree of dispersion increased. During electroslag refining of Cr-Ni-Mo steel, as the content of rare-earth metal oxides increases, a binding of the various inclusions, including sulphur and phosphorus, by the rare-earth metals occurs. When refining using fluxes containing rare-earth metal oxides, an equilibrium dislocation structure with minimum dislocation density is achieved in the metal. All these factors help to increase the ductility of electroslag metal. References 3: 2 Russian, 1 Western (in Russian translation).

12131/9835
CSO: 1842/105

UDC 620.17:620.18:669.295.5

RELATIONSHIP OF NATURE OF FRACTURE TO MICROSTRUCTURE AND PROPERTIES OF (α+β)-TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 45-49

[Article by L. I. Anisimova and A. A. Popov, Ural Polytechnical Institute

[Abstract] An attempt is made to establish the relationship of the structure, properties and nature of fracture of two-phase titanium alloys VT3-1, VT8 and VT9, cooled from 1100-900°C in air and in the furnace. The results of metallographic studies showed that for each of the alloys where are three major types of structure: small globule, thin plate and thick plate. The strength of the alloys is not determined by the morphology of the α phase: regardless of whether plate or globular structure is present, after cooling in air all the alloys have a tensile strength of 1030-1100 MPa. The study of the fracture surfaces of the alloys revealed three groups of typical fractures corresponding to the three types of microstructures: pit fracture for globular structure, semitearing for thin plate structure, and formation and merging of microcavities for thick plate structure, with the main crack propagation differing significantly from the other two types. The major influence on plastic properties and the nature of fracture of two-phase titanium alloys is that of the morphology of the α phase, which determines the nature of the deformation of the metal. References 7: 2 Russian, 5 Western (1 in Russian translation).

6508/9835
CSO: 1842/100

UDC 621.762:621.793

Ni-Ti COMPOSITE POWDERS: PRODUCTION AND PROPERTIES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 9 Jul 84) pp 13-16

[Article by Yu. S. Borisov, V. R. Kalinovskiy, Yu. A. Sidorenko, Z. P. Shurygina and N. N. Kokorina, Institute of Material Science Problems, UkSSR Academy of Sciences]

[Abstract] Composite powders, used widely in producing gas-thermal coatings, are subject to exothermic reactions during spraying. The present article reports on a study of titanium-nickel systems with widely varying ratios. The systems, which were produced by plating and conglomerating procedures, were both homo- and heterodispersed in structure. In the latter, nickel was deposited on larger Ti particles if Ni content was 15-45%, while with larger Ni amounts the nickel as a rule formed the core of the structure. A clear correlation between experimental and calculated density confirmed the stability of the production technology used. Differential thermal and analysis was used to determine reactions between the nickel and titanium and its dependence on composition and structure. It showed that where Ti content was 5-85%, the exothermic effect brought the composition to a fused state, with the best results occurring in the range of 25-70% titanium content. In heterodispersed structures, the optimum exothermic reaction occurred at 950-995°C if the core was titanium, and at 1005-1075°C if the core was nickel. References 3: all Russian.

12131/9835
CSO: 1842/101

UDC 621.793.72:533.9

POWDER MATERIALS AND TiCN-Ni-Mo COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 24 Jul 84) pp 59-63

[Article by M. Yu. Zashlyapin, N. V. Obabkov, B. V. Mitrofanov and G. P. Shveykin, Chemistry Institute, Ural Scientific Center, USSR Academy of Sciences; Ural Polytechnical Institute]

[Abstract] Because of a number of specific features of refractory compounds, composite plasma coatings based on them have high durability and resistance to wear caused by various factors including high temperature. The present article reports on attempts to produce TiCN-Ni-Mo composite powders of the conglomerate type and the plasma coatings based on them. The granulometric and phase compositions of the powders, their yield point and specific surface, as well as the structure, phase composition, hardness and wear resistance of the sprayed composite layers were studied. Powders produced by granulating suspensions were purged of an organic rubber binding agent and then heat processed in a vacuum, first at 500-600°C and then at 1200°C. X-ray phase analysis indicated that the composite powders contain titanium carbonitride, a solid nickel solution and molybdenum. The powders were then sprayed on using an argon-nitrogen plasma carrier. Solid and sufficiently plastic coatings were obtained. X-ray analysis of the coatings showed a TiCN phase, a nickel-based solid solution and molybdenum (in those specimens where the initial powder contained it). The coatings bonded well to the base metal, and hardness, microhardness, and wear resistance were positive features. References 6: all Russian.

12131/9835
CSO: 1842/101

UDC 621.783L669.018.45

CHANGE OF PHASE COMPOSITION OF VK8 POWDER DURING DETONATION-GAS APPLICATION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 25 Nov 83) pp 80-85

[Article by Yu. A. Kharlamov, B. L. Ryaboshapko, Yu. I. Pisklov and T. P. Shmyreva, Voroshilovgrad Machinebuilding Institute]

[Abstract] The present article reports on a study of the influence of a number of parameters of detonation gas spraying on the phase composition of coatings from the standard mechanical mixture VK8, specifically spraying distance, consumption of operating gases, shape of the application nozzle and consumption of carrier gas (argon) and powder. X-ray analysis of the data

showed that with spray distance of 120 mm and acetylene consumption of 179cm^3/cycle, the resulting coating contained W, W_2C, WC and Co_7W_6. Results indicated that physicochemical conversions in mechanical WC-Co powder mixtures are determined not only by the composition of the detonating gas mixture, but by reactions with combustion products and other factors. A slight increase of acetylene consumption to 183cm^3/cycle brought a significant increase in coating hardness, from 12.32 to 16.89 GPa. Careful analysis of all pertinent factors is required for optimum coating production. Increasing the duration of powder exposure to the detonation brought more complete physicochemical conversion in the powder. References 11: 10 Russian, 1 Western.

12131/9835
CSO: 1842/101

UDC 669.187.2:621.791.92:669.14.256

FLUX FOR ELECTROSLAG SURFACING OF HIGH-MANGANESE STEEL

Kiev PROBLEMY SPETSIAL'NOY ELEKTROMETALLURGII in Russian No 4, Oct-Nov-Dec 85 (manuscript received 4 Jun 84) pp 26-28

[Article by K. A. Valits, A. Ya. Shvartser and V. P. Stoyko, Donetsk Polytechnical Institute]

[Abstract] Reconditioning of mining and ore-concentration equipment by electroslag surfacing is often achieved using electrodes made of high-manganese 110G13L steel. The reliability and durability of the reconditioned parts is determined to a great extent by the quality of the fusion of the surfaced and the basic metal. In the fusion zone the most frequent defects are slag inclusions, the dimensions and quantity of which significantly affect the reliability of the reconditioned parts. Use of fluxes of the CaF_2-Al_2O_3-CaO system usually results in large slag inclusions which considerably weaken the fusion zone. The goal of present study was to develop a flux which ensures high-quality reconditioned parts by reducing the number and size of slag inclusions in the fusion zone and reducing the oxidation of manganese. The study involved the use of ANF-6 flux and, 4 experimental fluxes obtained by mixing ANF-6 and AN-348 fluxes with subsequent electroslag refining of the mix. The interphase properties of slags at the interface with liquid 110G13L steel when using the various fluxes are given. The data indicated that when the 4 test fluxes are used the formation of large slag inclusions is highly improbable study of the behavior of manganese during the electroslag surfacing and electroslag refining of 110G13L steel indicated that if ANF-6 flux was used the manganese content of the steel dropped more than 2.0% on the average but did not change essentially when the experimental fluxes, with additions of manganese oxide, were used. Tests under plant conditions have indicated that parts restored with the aid of the new fluxes are as good as new. References 3: all Russian.

12131/9835
CSO: 1842/105

UDC 669.187.2:537.533:621.187.1:[538.2+620.17].001.5

STRUCTURE AND PROPERTIES OF THICK VACUUM CONDENSATES Cr-Ce_2S_3

Kiev PROBLEMY SPETSIAL'NOY ELEKTROMETALLURGII in Russian No 4, Oct-Nov-Dec 85 (manuscript received 1 Jun 84) pp 41-46

[Article by N. I. Grechanyuk, G. G. Didikin, N. N. Kalinyuk and B. A. Movhcan, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] Dispersed particles of thermodynamically stable carbides, nitrides and other compounds are often used as the strengthening phase in heat resistant and heat tolerant metals. The present article reports on study of the structure and of certain properties of two-phase condensates of the Cr-Ce_2S_3 system. The initial materials were chromium ingots (0.0036% N, 0.31% O, 0.018% C, 0.33% Fe, 0.15% Si, 0.13% Ni, 0.42% Al and 0.027% Cu; the remainder Cr) and small bars of Ce_2S_3. The condensates were produced in the form of sheets 220 X 360 mm with thicknesses of 0.8-2.5 mm by electron-beam evaporation; they were subjected to stabilizing annealing at 900°C for 1 hour in a vacuum of $1.33 \cdot 10^{-3}$ Pa. Stability of the condensate structure was tested by annealing at 1100, 1200 and 1300°C for 5 hours in the same vacuum. Metallographic methods and transmission electron microscopy were used to study condensate structure. Results showed that mechanical properties of two-phase condensates of the Cr-Ce_2S_3 system depend on average crystal size and the mean free distance between the particles of the second phase. Maximum values of strength and particularly of ductility are attained when the average grain size of the matrix is equal to the mean free distance between particles of the second phase. References 5: all Russian.

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UDC 669.187.2:621.9.025.7

DENSITY AND MECHANICAL PROPERTIES OF Si_3N_4 CONDENSATES AND SiC-TiC SYSTEM

Kiev PROBLEMY SPETSIAL'NOY ELEKTROMETALLURGII in Russian No 4, Oct-Nov-Dec 85 (manuscript received 25 May 84) pp 46-51

[Article by A. V. Demchishin, G. F. Badilenko, A. Ye. Kushnirenko and N. L. Kareta, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] Carbides and nitrides are amond the few compounds that possess great hardness, wear resistance and resistance to aggressive media at elevated temperatures. Composites based on them have even better properties than the individual components in certain instances. The present article reports on a study of the mechanical properties, density and phase composition

of condensates of silicon carbides and nitrides and of condensated materials of the SiC-TiC system, produced by electron-beam evaporation and condensation at 1100-1350°C on a flat 1 mm thick molybdenum substrate, over a broad range of concentrations. Precipitation of TiC, SiC and Si_3N_4 was done in a vacuum at 13 MPa residual pressure, at a rate of 0.7-10 μm/min, and with calcium fluoride as a coating to ease subsequent removal of the deposited test specimens. Experimental data indicated that the density of SiC increased smoothly as substrate temperature increased from 1100 to 1250°C, amounting to 2810 and 2880 kg/m^3, respectively. Further temperature increases had little effect. The density curve for Si_3N_4 was similar but with lower values at identical temperatures. Changes in microhardness and ultimate strength of silicon carbides and nitrides during bending corresponded to the shape of the curves for their density. The SiC-TiC system was also studied. The data obtained indicated the promising nature of the use of mixtures of these carbides, in the area of 40-75 TiC content, as very hard and dense composite materials. References 11: 8 Russian, 3 Western.

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CSO: 1842/105

UDC: 669.18:621.793

ANALYTIC AND EXPERIMENTAL STUDY OF ISOTHERMAL CRYSTALLIZATION UPON FORMATION OF TITANIZED COATINGS ON STEEL

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY. CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 5 Dec 84) pp 106-109

[Article by V. I. Andryushechkin and I. P. Dashkova, Moscow Steel and Alloy Institute]

[Abstract] An attempt is made at analytic and experimental investigation of the process of isothermal crystallization in the Fe-Ti system in order to determine the possibility of regulating the phase composition, structure nad properties of coatings in this stage. Computations showed that the stage of isothermal crystallization was much (10 times) longer than the stage of contact melting. This allows regulation of the phase composition, structure, and properties of coatings in the stage of isothermal crystallization. Changing the duration of holding at the isotherm in the stage of isothermal crystallization can thus produce coatings with different structure, phase composition and, consequently, properties. Application of titanium layers to steel permits their protection when working in corrosive media, as well as replacement of expensive titanium alloys and stainless steel with carbon steel after titanium coating. References 5: all Russian.

6508/9835
CSO: 1842/106

UDC: 621.771.8

VARIATION IN BOND STRENGTH OF LAYERS AS A FUNCTION OF ENERGY STATE OF CONTACTING SURFACES DURING CLADDING OF BIMETALS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 1 Mar 85) pp 134-135

[Article by A. G. Kobelev, V. N. Lebedev and A. M. Vayduganov, Moscow Steel and Alloy Institute]

[Abstract] A study is presented of the influence of the initial surface energy σ unit, representing the status of contact surfaces before cladding, as well as surface energy σ, which determines the influence of plastic deformation on the bond strength of steel-copper bimetallic products. A formula for determining surface energy is given. The method is suitable for monitoring the quality of bimetals based on the amount of initial surface energy, which cahracterizes the degree of preparation of the contracting surfaces for cladding, and on the amount of surface energy which characterizes the effect of plastic deformation. Reference 1: Russian.

6508/9835
CSO: 1842/106

SOVIET GAS PIPELINE DEFECTOSCOPE

Baku BAKINSKIY RABOCHIY in Russian 3 Dec 85 p 3

[Article by R. Akhmetov: "Underground 'Eyes'" under the rubric: "News with Commentary"]

> [Text] Saratov. Steel pipelines, by and large, are found underground where the bitterest enemy of metal, corrosion, lies in wait for them. How is the condition of the pipe to be checked without removing it from the ground? A unique complex developed at the Saratov plant, Gazavtomatika, gives that possibility. Moving inside a main line, instruments reveal places damaged by corrosion. This permits changing a pipe in time to prevent an accident. The new unit has successfully passed tests. The first batch of them is now being manufactured.

Moscow. "Not one kind of transport in our country is developing at such a precipitous rate as pipelines" observes the report of the TASS correspondent, the head of a department of the Moscow NPO [Scientific Production Association], Spectr, and Doctor of Technical Sciences, Yu. Fedosenko. "This is explained by the high economy of underground transport."

With the development of networks of steel arteries supplying cities and plants with gas and raw chemicals, the problem of their reliability has become all the more important. Corrosion inflicts the principal damage on pipelines. A rusted-through pipe can rupture and that threatens a sudden blow-out of gas and explosion. An accident on a main pipeline leads to severe consequences; namely, huge losses of valuable raw materials, and pollution of the soil and water sources. Interruptions occur in the work of enterprises producing or processing fuel.

Gas and oil men are acutely in need of a new means of monitoring the condition of main, steel pipelines. On the solution of this complex scientific and technical problem, academic and industry science has been engaged; namely, the Institute of the Physics of Metals of the USSR Academy of Sciences' Ural Scientific Center, the Scientific Research Institute of Introscopy in the Spectr Association, and industrial workers.

Over a relatively short period of time, a defectoscopic unit was manufactured. Under the pressure of the powerful flow of gas, the device which has a 5.5 ton weight, rushes along in the pipe with a speed of 5-10 meters per second. From within, it "sees" the quality of the outside wall of the pipeline. How is this done?

The heart of the unit is a ring magnet which creates a strong magnetic field along the whole periphery of the pipe. In a place where the wall is thinner, having been attacked by corrosion, a so-called magnetic leakage flow arises. This effect is registered by a sensitive element. Instruments at once record on photographic film the place along the route that corrosion was revealed.

"Now we are working intensively on an improved model" said Yu. Fedosenko in conclusion. "I will explain one of its merits. Today, interpreting the photographic film, on which is recorded data on the condition of hundreds of kilometers of a gas pipeline, takes an operator a long time. In the future, the man will yield to a microcomputer which will do this in ten minutes."

Assuring the reliability of underground main pipelines and the development for them of modern means for technical diagnosis is a most critical problem for all industrially developed countries. In many ways, international cooperation is contributing to its solution. In Moscow in December specialists from the U.S.A., FRG, France, Japan, and other states will meet to take part in the symposium "Diagnostics for Pipelines-85". This is an acknowledgement of the authoritativeness of Soviet science in an important field of scientific and technical progress.

9136
CSO: 1842/91

UDC 621.771.22.022.4:669.14.018.8

REMOVAL OF METAL CHIPS FROM SURFACE OF CORROSION-RESISTANT STEELS DURING REFINING BY TREATMENT WITH OXYGEN AND FLUX

Moscow METALLURG in Russian No 12, Dec 85 pp 33-35

[Article by A. L. Dayker, V. S. Rybin, A. I. Veys, G. A. Katayevskiy, Ye. A. Luzin, E. G. Kirsanov, Ya. Sh. Beloglovskiy and V. S. Pyzhov, Scientific Research Institute of Metallurgy and Chelyabinsk Metallurgical Combine]

[Abstract] The present method of flame refining used in shop No 2 of the Chelyabinsk Metallurgical Combine for rolled blanks of stainless steels 12Cr18Ni10Ti, 12Cr18Ni9Ti, 10Cr17Ni13Mo2Ti involves cutting the surface with an oxygen flame, with iron powder serving as flux. This method is a sound one, but the mechanized equipment now in use has a few deficiencies which lower the technical and economic indicators of the process. The main problem are metal chips which remain on the surface and must be removed. A remedy has been designed which employs a water strike for chip removal, with provisions for separation and collection of chips containing scarce nickel. The mechanism consists of a two-way hydraulic channel and a pneumatic channel. Water is pumped in under a pressure head of 0.2-0.3 MPa and passed throggh a set of valves to one of two nozzles, the other nozzle serving for water wipe-off by flow in the opposite direction. Compressed air under a pressure of 0.4-0.5 MPa passes through a check valve, a filter, a pressure reducer, and a two-way valve to either of the two nozzles. A safety valve is provided behind the pressure reducer. Such a water strike and water wipe-off removes metal chips and slag particles as well as dust from the surface of a blank so that all preliminary and final refining operations can be completed in s ahorter time than they are now, with a resulting 36% increase of productivity and a lowering of the rate of metal rejection from 4.16% to 2.26%.

2415/9835
CSO: 1842/103

LARGE NEW STEEL PLATE-ROLLING MACHINE

Moscow PRAVDA in Russian 2 Dec 85 p1

[Article by PRAVDA correspondent V. Senin: "The First Plate" with the subhead: "From the Place of the Event"]

> [Text] Leningrad. In the Izhorskiy Zavod Association, the first start-up complex of the largest plate-rolling machine in the country, the "Kvarto-5000," has begun to produce output.
>
> The "5,000-mik" will provide not only itself but also other plants with steel plates and slabs with thicknesses from 10 to 450 millimeters and widths up to 5 meters.

The use of large plates, for example in assembling large-tonnage ships, will reduce the amount of welding work by a factor of 1.5. The products of the machine also promise a substantial saving of metal and labor expenditures in power and chemical machine building, and other industrial sectors.

Several months ago workers and engineers conducted a hot run-in of the mechanisms and set up the start-up and adjustment work and preparation of the machine for operation. A competition on the principle of "A Workers Relay Race" helped in a substantial measure to expedite the schedules. It permitted consolidating the forces of the designers, builders, installers, start-up adjusters, and operators to pass ahead of the planned periods of work on all objects.

The construction of the machine gave birth to many bold engineering decisions. Here, for the first time an assembly-by-assembly method of conducting large construction and installation operations was used. The brigades of A. Prosolov, V. Stoyko, L. Volkova and other collectives of trust No. 35 of Glavzapstroy [Main Administration for Construction in Western Regions of the RSFSR] displayed examples of shock labor. Then the brigades of installers of the Sevzapmetallurgmontazh and Sevzapstalkonstruktsiya trusts took up the race. Time and again the red flag was raised over the complex in honor of the collectives of the Vostokmetallurgmontazh and Soyuzprombummontazh trusts.

And here for the first time, they all - designers, builders, installers and operators - were gathered together beside the framework of the machine.

On command, the mouth of one of the reheating furnaces is opened and out comes a glowing ingot. At the control panel the operator threw a quick glance at the instruments and put the machine in motion. The conveyor started and slid the many-ton ingot to the framework of "Kvarto". The powerful force of the rollers caught it and squeezed. The framework withstands the strain of the rolling at 9,000 tons - its own weight is 5,500 tons. Longer and longer is the steel strip. Finally, there stands on the roller bed a finished rolled plate. The members of the State Commission give the verdict: the production equipment of the complex operates normally. The faces of the people, workers, and engineers lit up and they shook hands with one another.

The construction on the Izhora river was directed to tomorrow. The collective of the association, competing in honor of the 27th Party Congress, had obligated themselves to bring the start-up complex to designed capacity ahead of schedule.

9136
CSO: 1842/91

PROBLEMS WITH VACUUM-DEGASSING OF STEEL DESCRIBED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 18 Dec 85 p 3

[Article by I. Mosin, special correspondent: "Sideways to Progress: Why an Effective Method of Increasing Metal Quality is Being Introduced Slowly"; passages in slantlines printed boldface]

[Text] "If we could make bearings from vacuum-degassed steel, they would last at least 1.5 times longer," Deputy Director of the All-Union Scientific Research Institute for the Bearing Industry V. Zhukov removed a table of calculations from a file containing many years of correspondence. "And the annual savings would exceed 130 million rubles. Most important, we could save the country up to 120,000 tons of metal a year."

Bearing production is not the only field where vacuum-degassed steel promises huge resource savings. For example, it permits a reduction of current loss in transformers and reduces their size and metal intensiveness. Rails made of this steel are less vulnerable to wear and make it possible to increase the weight of rolling stock.

World practice long ago appreciated all these advantages. Today about 400 installations, in which all dynamo steel, 80 percent of the steel for roller bearings, and about 60 percent of the structural metal are vacuum-degassed, are operating overseas. Here, 12 units are operating at enterprises of the USSR Ministry of Ferrous Metallurgy, but vacuum-degassed steels constitutes only 0.6 percent. Isn't this one of the reasons we produce more steel than anyone, yet have a chronic metal shortage?

"The most vexing thing," notes V. Kashin, head of a laboratory of the USSR Academy of Sciences Metallurgy Institute and a doctor of technical sciences, "is that our country was the first to propose and implement a process for vacuum-degassing steel outside a furnace, but now we have lost our leading positions..."

The idea of vacuum-degassing outside the furnace put forth by Academician A. Samarin is outwardly simple: a ladle with molten metal is covered by a lid beneath which a strong vacuum is created. And the vacuum, like a pump,

removes harmful gaseous impurities from the metal. It is precisely in this form that the process was successfully assimilated in 1952 at the Yenakiyevo Metallurgical Plant. Why then have metallurgists turned "cold" toward vacuum-degassing. Could it be because the user enjoys all the benefits from improved quality?

"No, vacuum-degassing is beneficial for metallurgists as well," answers V. Kashin. "It makes it possible to reduce the time metal is held in the furnaces, transferring many finishing operations to the vacuum-degassing unit..."

The result is clearly seen in the example of the Cherepovets Metallurgical Combine. Introduction of vacuum-degassing there permitted a 12 percent increase in the productivity of the 100-ton electric arc furnaces, cut the consumption of expensive ferroalloys in half, and reduced electricity consumption by 10 percent. As a result, the production cost of a ton of finished plate dropped 18-20 rubles.

Considering these advantages, in 1980 the USSR Ministry of Ferrous Metallurgy was assigned the task of raising the annual volume of vacuum-degassing to 4 million tons, but failed to do so. Even 5 years later, this year, the Ministry has projected a more than modest vacuum-degassing plan--2.5 million tons. However, already today we can say that it will not be fulfilled.

"Everything depends on the machine-builders," Yu. Vyatkin, chief steelmaker of the Engineering Administration of the USSR Ministry of Ferrous Metallurgy, explains the reason for these failures. "The vacuum-degassing installations which they deliver to us are not even worth talking about, either in terms of design or reliability."

Yes, machine-builders have provided just cause for serious complaints. As early as 1971, development (razrabotka) of vacuum-degassers was assigned to the All-Union Scientific Research Institute for Metallurgical Machine-Building (VNIIMetmash)--the leading institute of the Ministry of Heavy and Transport Machine-Building. Of course, it was a question of more complex units than A. Samarin's first-born. But references to complexity are no excuse: It took the machine-builders 10 years to create (sozdaniye) the first three vacuum-degassing units.

By the way, it was a matter not only of deadlines, but also of the technical level of the new machines. Downtime for one of these units at the Chelyabinsk Metallurgical Combine amounted to 26 months because various systems and assemblies had to be rebuilt and remodeled. It took 1.5 million rubles to eliminate the defects in the vacuum-degassing system for Azovstal'. Neither unit has yet reached design capacity. And the vacuum-degassing unit for the Donetsk Metallurgical Plant has been declared completely unfit for operation.

An unavoidable question arises: "How could such 'new technology' come into the world?" Let us assume that VNIIMetmash designers were unprepared

for the tasks. But, one asks, where was the buyer, the USSR Ministry of Ferrous Metallurgy, and its industrial science when these assemblies were being designed and put into production?

It wasn't easy for Ministry personnel to recall that, in the early 70s, the role of the lead organization for vacuum-degassing was assigned to the Chelyabinsk Metallurgical Scientific Research Institute (NIImetallurgii). Having neither experience nor scientific capabilities (zadel), it couldn't handle this role. The Ministry of Ferrous Metallurgy personnel allowed the work to drift. And departmental ambitions left the pioneers in vacuum-degassing--USSR Academy of Science Metallury Institute scientists--on the sidelines. It was they who shed light on the Ministry's "policy."

"It's not just a matter of the machine-builders' errors," says A. Lukutin, candidate of technical sciences. "Their intractability helped the Ministry of Ferrous Metallurgy buy equipment abroad. They could buy, so they bought. But you'll be interested to know how it is being used..."

A joyless picture unfolded. Of the three vacuum-degassing units bought in recent years, one is a heap of parts lying at the Orsk-Khalilova Metallurgical Combine. The second unit was installed at the same enterprise. It permits processing of up to 350,000 tons of metal a year. The Ministry plan calls for 290,000 tons, but in 9 months this year only 39,000 tons have been vacuum-degassed. The situation at the Donets Metallurgical Plant, where the third vacuumizer is installed, is a little better. Given an annual plan of 150,000 tons, a little more than 80,000 tons of steel have been treated there in 9 months.

"How do you intend to correct the situation?" I asked Yu. Vyatkin.

"In the next five-year plan, we want to reach 11.5 million tons per year," the Chief Steelmaker became animated.

"You mean just vacuum-degassing?"

"No. The five-year plan includes all types of out of the furnace treatment," Yu. Vyatkin reluctantly admits.

"And how much vacuum-degassed steel does the entire national economy need?"

"I don't know. No one in the industry is studying this question."

Should we be surprised then that the program for the next 5 years does not call for concentration of efforts. Just the opposite. USSR Ministry of Ferrous Metallurgy personnel again want to raise the question of buying equipment abroad. How long will this go on? Aren't our scientists, designers, and production people themselves able to ensure widespread introduction of vacuum-degassing?

One would think that they can. The "excommunication from the industry" on the ministry level has not kept academic science from cooperating with individual enterprises. In particular, with the help of scientists from the USSR Academy of Science Metallurgy Institute, specialists of the Cherepovets Combine have, by their own efforts, created and started up the vacuum-degassing unit mentioned above, and for 13 years it has satisfied all requirements for relay steel.

With the participation of academic science, specialists of the Novolipetsk Metallurgical Combine and the local polytechnical institute have created an essentially new vacuum-degassing process combined with continuous steel casting. But neither the national Gosplan nor the State Committee for Science and Technology have succeeded in detecting any sign that the Ministry is achieving its extensive introduction.

By the way, just who should be doing this? It seems that even now Ministry of Ferrous Metallurgy personnel are not unwilling to shift all responsibility for the development of this promising trend to industrial science. This time, the role of the lead organization has been assigned to TsNIIchermet (Central Scientific Research Institute of Ferrous Metallurgy). More precisely, to its laboratory for out of the furnace treating of metal, which has a staff of 25. Their scope of work includes not only all known treatment methods, but also adjustment of the processes... on the vacuum-degassers that were bought. One asks what kind of radical changes can be effected by such forces.

"We will do everything in our power," responds the laboratory's director, I. Kulikov, candidate of technical sciences. "In my opinion /the tasks for for ferrous metallurgy in the Basic Directions should specifically indicate the volumes of vacuum-degassing as the predominant processing technique to improve metal quality. Correspondingly, the tasks for machine-builders should provide for the production of equipment for such processing, along with converters and continuous steel casters./ Finally, to solve these problems, we have to combine efforts, precisely organize these efforts, and monitor progress."

Who should assume this organizing role? If we start with the tasks assigned in the draft Basic Directions,--the State Committee for Science and Technology. But...

"We aren't working on vacuum-degassing," stated A. Samsonov, a chief specialist in the Metallurgy Department. "In the scientific and technical sense, this problem has already been solved. Our task is to look to the future. However, in our opinion, it is related to AKOS--integrated steel processing units."

It seems that workers in the Committee's Metallurgical Department have rushed to distance themselves from the vacuum-degassing problems, but there are several "blank spots" in scientific and technical terms as well.

An example is the errors of the VNIIMetmash designers. In turn, one of their leaders, V. Reshetov, justifiably points to the lack of high-powered vacuum pumps, reliable hydraulic equipment and automation devices, and durable refractories. Even the AKOS--indisputably a promising unit--is essentially the same vacuum-degassing unit equipped with devices for heating steel and blowing by various reagents. That means that the old ailments may recur during its creation.

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CSO: 1842/116

STEEL SMELTING COMPLEX AT FAR EASTERN PLANT OPERATIONAL

Moscow PRAVDA in Russian 21 Dec 85 p 1

[Article by B. Khatyntsev, staff correspondent: "Stal' in Operation"; passages in slantlines printed in boldface]

[Text] /At the Far Eastern Semi-Integrated Metallurgical Works, which is now being built, the Stal' complex has gone into operation. The more than 500,000 tons of steel which the plant must melt every year will significantly improve metal supply to construction sites and industrial enterprises in the Far East./

Construction of the complex has required concentration of the forces of builders, installers, power engineers, and metallurgists. The Komsomolskmetallurgstroy Trust was established four years ago. The construction project was designated as an All-Union shock project, and more than 8,000 young men and women came from all corners of the country on Komsomol assignment. Twenty-five dormitories were erected for them. In the months before startup, installation specialists from Arkhangelsk, Khabarovsk, and other cities came to help.

The tight deadlines of the pre-startup period stimulated those involved in construction to master new forms of labor organization and to use progressive technology. Thus, F. Sharlaimov's brigade from Komsomol Installation Administration No1 2 of the Dalnetekhmontazh Trust used a method of assembling by consolidated units to erect the electric steel-melting furnaces, which helped cut the schedule in half. Brigade leader V. Deriglazov's collective from SU [Construction Administration]-11 of the Komsomolskmetallurgstroy Trust has been able to use 1.5 million rubles since the beginning of the year. This integrated 100-man team is working as a construction section.

On the basis of the experience of related enterprises already operating in Belorussia and Moldavia, the Far Eastern metallurgists have introduced several design changes to increase equipment during the startup and adjustment work reliability.

"We have trained hundreds of specialists to maintain the new production facility," says the director of the neighboring giant, Amurstal',

L. Rozhko. "Our plant is to be rebuilt, so we hope that the skill the builders have gained will tell in the results. However, first thing next year, we will have to deal with putting the "Prokat" complex, the plant's second stage into operation."

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UDC 621.74.002.6:669.13

CAST IRON WITH VERMICULAR GRAPHITE FOR MARINE DIESEL ENGINES

Moscow LITEYNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 5-6

[Article by R. I. Khosen, doctor of technical sciences, V. M. Grigor'yev, engineer and S. A. Torubarov, engineer]

[Abstract] Both the mechanical strength and the wear resistance of cylinder blocks for diesel engines operating on maritime vessels will be increased by addition of vermicular graphite to the doped cast iron (2.8-3.5% C, 1.6-2% Si, 0.8-1.2% Mn, 0.3-0.7% Cr, 0.3-0.7% Ni, 0.1-0.25% P, 0.05-0.12% S) from which they are now made at the Khabarovsk Diesel Manufacturing Plant (Dal'dizel'). Such iron is produced by smelting cast iron and steel scrap in an induction furnace with acid lining and poured from a ladle with "stsemish"-3 and SB20 barium-silicon alloying compositions on the bottom at 1450-1470°C. The technology has been developed using an IST-006 induction furnace for this purpose. Study of the mechanical characteristics of the product and metallographic analysis was done using solid specimens with lugs. While "stsemish"-3 serves as modifier, barium-silicon inhibits cementite formation somewhat and allows more "stsemish"-3 to be used so that the ratio of pearlite to ferrite becomes better controllable. Such a process will eliminate the need for subsequent heat treatment of cast iron ingots and will lengthen the service life of cylinder blocks, resulting in considerable savings. References 2: both Russian.

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UDC 669.15:539.213

ELECTRON-CONCENTRATION INHOMOGENEITIES AND DOMAIN STRUCTURE IN AMORPHOUS IRON ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 19 Jul 84) pp 695-702

[Article by L. S. Palatnik, L. I. Cheremskoy, L. I. Lukashenko, S. T. Roshchenko, B. A. Avramenko, L. G. Murovtsev and O. L. Utevskaya, Kharkov Polytechnic Institute imeni V. I. Lenin]

[Abstract] A study was made of two amorphous magnetic iron alloys, Fe-B pure and doped with Sb, Ce. or Nb and Fe-Ni-P in the form of tape produced by quenching from the melt on the surface of a drum. Microinhomogeneities associated with nonuniform electron concentration and influencing the magnetic characteristics of these tapes such as low coercive force and high magnetic permeability, were examined by the method of low-angle x-ray scattering in a diffractometer with a λ-CoK_α source. The domain structure was examined by the method of iron-powder figures. While x-ray scattering at angles $2\theta < 3°$ in 25-30 μm thick specimens revealed a distribution of local inhomogeneities in the form of a "void phase," doping the Fe-B alloy with Sb was found to increase its hydrostatically measured density from 7.39 g/cm^3 to 7.47 g/cm^3 and addition of surfactants was found to decrease its density to 7.15 g/cm^3 with corresponding decrease and increase of the scattering power. The scattering power of the Fe-Ni-P alloy was found to increase upon heating to 200°C, without significant change in its hydrostatically measured density, evidently as a result of local phosphorus microprecipitation. The domain structure of all alloys, according to powder figures in a normal magnetic field applied once horizontally and once vertically, appeared to consist of wide bands separated by zigzag boundaries, narrow bands separated by straight boundaries, and bands with magnetization in the plane of the tape separated by 180° boundaries. Except in some regions of doped Fe-B tape, the orientation of those domain bands did not depend on the direction of prior demagnetization and was determined by the local anisotropy. Doping, therefore, tends to reduce the local planar anisotropy, while annealing reduces initial compressive stresses and thus allows the microinhomogeneities to become the dominant factor influencing the anisotropy. References 6: 3 Russian, 3 Western (2 in Russian translation).

2415/98345
CSO: 1842/94

UDC 669.15'26-194:539.538

STRUCTURE AND WEAR RESISTANCE OF HIGH-CHROMIUM AUSTENITIC-FERRITIC STEELS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 29 Jun 84, in final version 21 Jan 85) pp 785-791

[Article by I. I. Kositsyna, V. V. Sagaradze, L. G. Korshunov and N. L. Pecherkina, Metal Physics Institute, Ural Science Center, USSR Academy of Sciences]

[Abstract] Structural and phase transformations in ferritic high-chromium steels during heat treatment were studied for the purpose of determining the dependence of hardness and wear on the structural state. Three steels were selected for the study and produced in an induction furnace: low-carbon molybdenum steel Cr28N18Mo2 (0.01% C, 28.3% Cr, 8.6% Ni, 1.9% Mo, 0.22% Mn, 0.20% Si) and high-carbon molybdenum steel 65Cr28N18Mo2 (0.65% C, 29.4% Cr, 8.0% Ni, 1.8% Mo, 0.22% Mn, 0.15% Si) as well as plain low-carbon chromium-nickel steel Cr27N19 (0.01% C, 26.9% Cr, 9.4% Ni, 0.10% Mn, 0.16% Si). Billets forged from ingots weighing 10 kg each were rolled into bars of 10x10 mm^2 cross-section. These were quenched from 1250-1300°C and then slowly heated to temperatures of 300-900°C at a rate of 0.3°C/min. They were also isothermally soaked at temperatures of 400-950°C for 1-2-5-10-20 h. Microstructural examination was performed under an "Epityp-2" optical microscope and a JEM-7A electron microscope. X-ray analysis was performed in a DRON-2.0 diffractometer with a CuK_α source. Hardness was measured on the Rockwell C scale (1.47 kN load) and on themicrohardness scale (0.49 N load). Mechanical tensile tests were performed by standard methods at room temperature. Magnetic measurements were made with a Steinberg-Zuzin magnetometer in a magnetic field of 195 kA/m intensity. Wear tests were performed under dry friction with a pin of Cr28N18Mo2 steel sliding against a plate of Cr12Mo steel in reciprocating motion and under abrasive action with a 20 mm long bar of 7x7 mm^2 cross-section rubbing against 14A16NM14 paper. The results reveal an intense breakup of ferrite in both Cr-Ni-Mo steels, with α'-phase precipitation within the 450-500°C temperature range and σ-phase precipitation within the 700-900°C temperature range as well as austenite formation including b.c.c.-f.c.c. displacement transformation within the wide 450-1000°C temperature range and each requiring a certain length of treatment time. The data reveal that hardness and wear rate correspond to the structural states of these alloy steels. References 12: 6 Russian, 6 Western.

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UDC 669.15'24:620.186.1

CRYSTALLOGRAPHIC RELATION BETWEEN PHASES DURING NORMAL $\gamma \rightarrow \alpha$ TRANSFORMATION IN Fe-Ni ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 3 Dec 84) pp 822-824

[Article by A. N. Moiseyev, M. P. Usikov and E. I. Estrin, Institute of Metallography and Metal Physics; Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] An experimental study of the normal $\gamma \rightarrow \alpha$ transformation in Fe-Ni alloys was made for the purpose of establishing the crystallographic relation between the two phases. Since in a normally transformed Fe-Ni alloy the γ-phase does not exist at room temperature, the initial orientation of a γ-grain was reproduced on the basis of the orientation of two neighboring α-crystals which had grown in such a grain. Two alloys had been selected for this study, Fe + 6% Ni and Fe + 9% Ni with 0.01% C each. The $\gamma \rightarrow \alpha$ transformation was controlled to ensure the normal mechanism with the possibility of at least three α-grains forming within a γ-grain. An analysis of spectrographic projections andmicrophotographs taken under an electron microscope revealed a crystal-grain orientational coupling in 10 out of 13 specimens, with only an intermediate but close to it orientational coupling of either the Nishiyama-Wasserman type or the Grδninger-Troiano type in the others. References 8: 5 Russian, 3 Western.

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COMBINATION BLOW OF METAL BY FEEDING INERT GAS THROUGH CONVERTER BOTTOM

Moscow STAL' in Russian No 11, Nov 85 pp 16-21

[Article by Ya. A. Shneyerov, S. Z. Afonin, V. V. Smotkiy, B. I. Ashpin, R. S. Ayzatulov, E. S. Belokurov, N. Yu. Vinnik, L. M. Uchitel', Ye. Ya. Shapiro and I. V.KKabanov, Institute of Ferrous Metallurgy, USSR Ministry of Ferrous Metallurgy; West Siberian Metallurgical Combine; All-Union Institute of Refractory Materials; VNIPIchermstenergoochistka]

[Abstract] For the steelmaking process at the West Siberian Metallurgical Combine, a new technology has been developed for blowing the molten metal and new equipment has been built for adaptation of the 160 ton converters. The gist of this new method is the feeding of inert gas, a combination of nitrogen and argon, from below through the converter bottom along with compressed air, while feeding oxygen from above. This improves the burn-up of carbon oxide in the flue gases within the converter space and permits reducing the amount of molten pig iron needed for the operation. With

scrap metal filling 25% of the space, pig iron (0.45-1.05% Si, 0.48-0.80% Mn, 0.20-0.30% P, 0.018-0.030% S) is poured in at 1300-1400°C. Lime containing 80-90% CaO of the 10-60 mm grain-size fraction and fluorspar are used as slag producers. Heat-treated molded periclase-chromite with graphite, and with synthetic resin as binder, serves as lining material for single-channel shorter and multichannel longer tuyeres as well as for the converter bottom. Conventional tuyeres are used, but raising them and arranging them in two tiers has, together with combination blowing through the converter bottom, resulted in saving 33-40 kg of pig iron, 4.0-6.0 kg of lime and 1.4-1.7 kg of fluorspar per ton of steel. Over 4500 batches of low-carbon steel have been processed by this method, including 34 pilot production runs. The blow operation is completed when the carbon content has dropped from initial 0.20% or higher to 0.12% or from initial lower than 0.20% to 0.06%. The following participated in the development and setup of this new blow operation: O. L. Kazyrskiy, A. G. Vyshivanyy, V. M. Protsenko, Yu. A. Marakulin, A. P. Nekrasov, L. F. Pundel', A. L. Ryazanov, V. G. Borisov, D. Ye. Denisov, Ye. A. Sutyagin, A. L. Nikolayev, S. P. Zherebtsov and I. Ye. Sikulyar.

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TREATMENT OF LOW-ALLOY STEEL WITH INERT GASES THROUGH POROUS SEAMS IN LADLE BOTTOM

Moscow STAL' in Russian No 11, Nov 85 pp 21-22

[Article by A. F. Volodin, V. I. Machikin [deceased], N. M. Blashchuk, V. S. Zhivchenko and V. I. Shevchenko, Donetsk Polytechnic Institute and Makeyevka Metallurgical Combine]

[Abstract] Treatment of low-alloy steel with argon and nitrogen by blowing them through the porous ladle seams was studied on a cold laboratory model of a ladle at the Donetsk Polytechnic Institute. A ring with a median radius equal to 70% of the ladle radius was found to be the hydrodynamically optimum blower. A subsequent evaluation of such a design at the Makeyevka and Azovstal' steelmaking plants has confirmed its advantages. Itsfacilitates distributing the gas stream over the metal volume without formation of breakers on the free surface of molten metal. It prevents discontinuities in the slag blanket and, consequently, secondary oxidation of the metal. It contributes to a more uniform temperature distribution in the metal mass as well as to homogenization of the metal, chemically, during deoxidation and alloying, also to a lower amount of nonmetallic and gaseous inclusions. Such a ring is best formed by bricks acting as a siphon in the ladle bottom lining. Successful results wre obtained by blowing 08G2S, 60S2A, 14G2 steels in 250 ton ladles through such rings in the bottom. D. Ye. Demidov participated in the study. References 4: all Russian.

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CSO: 1842/95

UDC 669.187.26:621.365.3

DEOXIDATION AND MICROALLOYING OF HIGH-TONNAGE ELECTROSLAG-SMELTED INGOTS WITH ALUMINUM

Moscow STAL' in Russian No 11, Nov 85 pp 23-24

[Article by Al. G. Shalimov, B. B. Chapin, I. V. Kapustin, Yu. L. Ogurtsov and A. A. Galushka]

[Abstract] Deoxidation of electroslag-smelted and carbonitride-hardened steel with aluminum was studied, aluminum being added as microalloying element in amounts of 0.036-0.040% to 16G2AF steel and not exceeding 0.002% to 03G4N2MAF steel while large ingots of these two steels were poured by a continuous-casting machine from a high-tonnage converter into a crystallizer. One major problem is equalizing and stabilizing the aluminum concentration over the ingot height. A quantitative analysis of the results, assuming that the reaction 2 [Al] + 3 (FeO) → (Al_2O_3) + 3 [Fe] with the rate constant $K_1 = a(Al_2O_3)/(a^2_{[Al]} \cdot a^3_{(FeO)})$ equal to $\log K_1 = 45770/T - 8.0$ (T- absolute temperature) is the most likely one to be occurring, indicates the feasibility of achieving this. Since the final aluminum content in electroslag-smelted metal depends on the aluminum content in the electrodes and on the oxidation potential of the slag bath, it is necessary to use consumable electrodes with a very low aluminum content for slag production. It is then possible to save 2.0-222 kg of aluminum per ton of steel. Participating in the study were N. A. Stovbun, V. V. Lyashenko, N. A. Lukyanova and V. Ya. Zheliba. References 4: 3 Russian, 1 Czechoslovak.

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IMPROVING QUALITY OF ShKh15-ShD STEEL

Moscow STAL' in Russian No 11, Nov 85 pp 24-25

[Article by M. S. Vul'fovich, N. V. Stetsenko, I. Yu. Zykov, E. I. Tsvirko and N. M. Burova]

[Abstract] The quality of ShKh15-ShD ball-bearing steel, a steel of extra-high purity produced by melting in an electric furnace and smelting in an electroslag furnace, will be improved by modification of the subsequent purification process. Cooling the ingots with helium and regulation of the cooling rate will optimize the geometry of the molten metal pool and decrease its depth within the detachment zone, with a resulting more uniform density and dispersion of the solidified metal. The development of this method is based on metallographic examination as well as on quantitative analysis of residual nonmetallic and gaseous inclusions. Participating in the study leading to development of this method were A. P. Sabadyr,

I. Yu. Tregubenko, V. I. Dobrovol'skiy, M. A. Tel'mach, Ye. I. Slobozhanskaya, S. L. Yelenskaya and A. M. Vorontsova. References 2: both Russian.

2415/9835
CSO: 1842/95

UDC 669.187.26

AUTOMATION OF ELECTROSLAG SMELTING

Moscow STAL' in Russian No 11, Nov 85 pp 29-30

[Article by M. Ye. Al'perovich, V. P. Kubikov, V. N. Yermakov, K. Ya. Fedotkin and V. I. Kalinin]

[Abstract] A new technology of electroslag smelting has been developed in which the stationary crystallizer is moved vertically up and down and much longer ingots can thus be produced. Deoxidizers (Al, Ti) with fluxes and other alloying elements (Mn, Nb), in powder form, are fed in a stream of inert gas such as argon at a stringently regulated rate. The entire smelting process, especially movement of the crystallizer and batching of deoxidizers through the hopper, is automatically program-controlled with both voltage and current as coordinates. Any displacement of the electrodes from centerpposition is indicated by a light and a sound, for corrective action. This automatic control system has passed the test in a series of steelmaking production runs with one of the industrial electroslag-smelting furnaces.

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UDC 669.14.018.41:539.41

EFFECT OF SULFIDE INCLUSIONS ON DEFORMATION AND FRACTURE OF ON16 COLD-RESISTANT STEEL

Moscow STAL' in Russian No 11, Nov 85 pp 65-68

[Article by L. I. Gladshteyn, O. Ya. Vesolaynen, R. A. Miliyevskiy, B. P. Sharov and V. N. Zikeyev, Central Scientific Research and Design Institute of Structural Steel Work and Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] Since the strength of all nickel steels is largely limited by nonmetallic inclusions but no data are available on the role of such inclusions in the fracture of cold-resistant 6% Ni and 9% Ni steels, a

study was made for a determination of their role in ON16 steel (-0.10% C, 6.5-8.0% Ni, 0.3-0.6% Mn, 0.16-0.35% Si) containing 0.004-0.042% S and up to 0.020% P. Five ladles of that steel (0.004% S, 0.008% S, 0.013% S, 0.022% S, 0.042% S) were deoxidized with silicon and aluminum (0.8-1.0 kg/t) during melting; the melt was cast into 17 kg ingots, and the latter were forged into bars of 60x60 mm^2 cross-section. These were rolled lengthwise in two passes at 950-1200°C and the final 12 mm thick strips were heat treated as follows: normalizing twice, first time at 900°C and second time at 790°C, then tempering at 580-590°C for 1.5 h. Metallographic analysis has revealed a predominance of MnS_2 inclusions, of prolate shape with a slenderness ratio ranging from 2 to 140, their total effective length increasing with higher sulfur content. Subsequent mechanical tests in simple flexure as well as in impact on specimens with semicircular notch and on specimens with a fatigue crack acting as stress riser, at temperatures from -196°C to +20°C, have revealed no appreciable systematic dependence of stiffness and percentage deformation on the sulfur content but an appreciable decrease of toughness and ductility with increasing sulfur content. The adverse effect of an increased sulfur content and therefore more MnS_2 inclusions is more significant at the lower levels of sulfur content, an increase of the sulfur content being there more significant percentage-wise. It therefore is necessary to hold the sulfur content well below the normal 0.010% limit, even below 0.005%, which can be achieved by addition of calcium or rare-earth metals. T. N. Rivanenok and I. V. Bekreneva participated in the study. References 11: 6 Russian, 5 Western (1 in Russian translation).

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CSO: 1842/95

UDC 621.762:669.14.018.252.3

CARBON LIQUATION IN HIGH-SPEED CUTTING POWDER-METAL STEELS

Moscow STAL' in Russian No 11, Nov 85 pp 77-79

[Article by A. N. Popandopulo and V. I. Kalinina, Leningrad Polytechnic Institute]

[Abstract] High-speed cutting steels produced by powder metallurgy are characterized by minimal dendrite liquation and carbide liquation; however, they are still prone to oxygen, sulfur, and carbon liquation. Oxygen liquation and sulfur liquation have already been analyzed and methods of minimizing them are known, but the mechanism of carbon liquation is not yet quite understood. A study of it was therefore made for the purpose of minimizing it. Specimens of 10R6M5-MP steel (1.0% C, 3.8% Cr, 5.2% Mo, 6.7% W, 2.1% V) were analyzed, its powder was sieved and the various size fractions were heat treated. Specimens of M6F1-MP, M6F3-MP, R6M5F3-MP steels differing in their carbon content were also heat treated and analyzed, without sieving. The heat treatment involved quenching from

1200°C, then tempering either successively at 550°C, 560°C, 600°C, or three times at 560°C, for 1 h and then at 620°C for 4 h with testing for red hardness. Phase analysis was performed in a URS-50IM x-ray ionization diffractometer with a FeK_{α}-radiation source for a determination of the residual austenite and of the carbon content in the martensite as well as of Me_3C and Me_7C_3 carbides precipitating from the martensite during partial breakup of the latter. The results indicate that carbon liquation is intensified by reduction processes occurring within enclosed powder capsules during their heating for extrusion. Carbon released by dissociation of cementite reduces the oxide film and forms carbon monoxide which, if not completely adsorbed by the getter, dissociates upon contact with the metal powder into carbon and carbon dioxide ($2CO \rightarrow CO_2 + C$). The metal powder thus becomes carbonized and cementation of its finer grains with large specific surface area can occur. As the carbon content increases, moreover, so does the amount of residual austenite in the coarser grains of the metal powder. For minimum carbon liquation, the carbon content in powder steel should not be higher than in the corresponding cast steel and the impurity content in the metal powder should be decreased. Carbon liquation will be further inhibited by quenching from a lower temperature and tempering at a higher temperature. References 10: all Russian.

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UDC: 669.173.094.1.22:53.092

INTENSIFICATION OF CARBOTHERMIC AND COMPLEX REDUCTION OF IRON

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 23 Apr 85) pp 6-11

[Article by V. N. Vlasenko and V. K. Simonov, Dnepropetrovsk Metallurgical Institute]

[Abstract] A study of the influence of elevated gas phase pressure P on the kinetics of carbothermal and complex reduction of iron oxides was performed on an installation with continuous automatic recording of the change in mass of specimens and periodic determination of the quantity of reaction products in the departing gasses. Chemically pure Fe_2O_3 and magnetite concentrate from the Northern Mining and Beneficiation Combine containing 70.4% Fe_{tot} were used as the iron-ore materials. The carbonaceous reducing agents were, charcoal and graphite. A study of the kinetics of carbothermal reduction of iron showed that the most effective pressure was 392 kPa. When P was raised to 392 kPa, the mean rate of reduction of Fe_2O_3 by charcoal at 1273 K increased from 0.20 to 0.27% O/min. The influence of increasing pressure on the kinetics of the carbothermal reduction of iron is related to the acceleration of both stages of the process. A reduction in carbon dioxide content in the gaseous products indicate that the effect of

intensification is more greatly related to the acceleration of the gasification of solid carbon than indirect reduction reactions. References 6: all Russian.

6508/9835
CSO: 1842/106

UDC: 669.131.6:546.655

ALUMINUM, MAGNESIUM AND CERIUM REDUCTION OF HIGH-CARBON IRON ALLOYS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 23 Jan 85) pp 25-28

[Article by D. N. Khudokormov, A. F. Vishkarev, S. N. Lekakh, V. A. Rozum, I. V. Zinkovskiy and N. I. Bestuzhev, Belorussian Polytechnical Institute; Moscow Steel and Alloys Institute]

[Abstract] A study of the process of deoxidation of high-carbon iron alloys was performed by the emf method, which has been successfully used in analysis of the activity of oxygen in steels. High-carbon alloys were prepared from materials of high purity to increase accuracy. The activity of oxygen in these high-carbon alloys of iron was found to depend significantly on the silicon content as well as temperature. The degree of deoxidation of the cast iron by magnesium and rare earth metals is influenced by the sulfur content. Estimating the activity of oxygen in liquid cast iron permits effective monitoring of the quality of high-strength cast iron. References 3: all Russian.

6508/9835
CSO: 1842/106

UDC 669.187.2:669.181.4

PRODUCTION OF HIGH QUALITY STEEL BY ELECTROSLAG SMELTING OF METALLIZED PELLETS IN CRYSTALLIZER MOLD

Kiev PROBLEMY SPETSIAL'NOY ELEKTROMETALLURGII in Russian No 4, Oct-Nov-Dec 85 (manuscript received 19 Sep 84) pp 3-7

[Article by A. G. Shalimov, Al. G. Shalimov, A. Ye. Volkov and V. A. Aleksandrov, Central Scientific Research Institute for Ferrous Metallurgy imeni I. P. Bardin, Moscow]

[Abstract] Together with the Novokramatorsk Machinebuilding plant (NKMZ) and other organizations, the authors' institute has been developing a new technological process, electroslag melting of metallized pellets in a crystallizer

mold. The goal is to create a technology and equipment for producing high-quality metal directly from the pellets, by-passing the stage of outside of the furnace processing and pouring. The essence of the process is the fusion of pellets, deoxidizers and alloying components in a layer of superheated slag in a cooled crystallizer with the simultaneous forming of an ingot of given chemical composition under the slag layer. The technology includes the continuous feeding of all components in a given ratio into the slag using weight controlled batchers and the maintenance of a stable slag composition and temperature condition. There are 3 sources of slag formation in the smelting process: the initial metallized pellets, oxidation and reduction products, and special additives to correct the chemical composition. Thus the amount of slag in the crystallizer grows constantly during the smelting process and equals 6-7% of the total metal content. The process is being implemented on an experimental basis at the NKMZ. The "Tulachermet" Scientific Production Association produced pellets which contain up to 25% iron oxides. The alloying elements were produced by NKMZ and several other organizations. The metal produced by the new process prossesses improved mechanical properties. Energy consumption (900-1300 KWT per hour/ton) is 15-25% less than for the previous technology. The high quality of the steel produced, the low unit energy costs and the possibility of complete mechanization and automation are the advantages of this process. Further study and improvements of the process and expansion of the range of products produced are required.

12131/9835
CSO: 1842/105

UDC 669.14.018.29

INFLUENCE OF NICKEL, COBALT AND HEAT TREATMENT ON STRUCTURE AND PROPERTIES OF VKS6 STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 15-19

[Article by A. F. Petrakov, A. P. Gulyayev, N. G. Pokrovskaya, L. N. Belyakov, V. N. Zikeyev, N. I. Ostroukhova, All-Union Aviation Materials Institute; Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] A study was made of the influence of nickel and cobalt content, conditions of heat treatment and operational heating on the phase transitions and mechanical properties of type VKS6 steel. Its properties as a structural material are evaluated, including its properties in corrosive media, in comparison to the widely used type 30KhGSN2A steel. Studies were performed on vacuum-arc-remelted steel obtained under laboratory and industrial conditions. The studies show that large quantities of residual austenite are undesirable in 9Ni-4Co (VK56) steels, since this decreases strength. An increase in residual austenite by 1% decreases ultimate rupture

strength by 50-60 MPa and yield point by 50-90 MPa. The quantity of residual austenite can be decreased not only by alloying with cobalt but also by decreasing the nickel content. After tempering at 530-560°C, the steel has good corrosion cracking and fatigue resistance, low sensitivity to stress concentrators and good toughness over a broad temperature range. After low tempering, these steels have no reliability advantage over 30KhGSN2A. The steel is practically insensitive to tempering brittleness, retaining its properties after long term heating to 550°C, and can be used for manufacture of parts operating at up to 550°C. References 4: all Russian.

6508/9835
CSO: 1842/100

UDC 669.14.018.29

STRUCTURE AND MECHANICAL PROPERTIES OF NORMALIZED LOW-PEARLITE Mn-V STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 19-22

[Article by D. P. Khromov, D. N. Khromushkin and K. B. Botvinnikova]

[Abstract] A study is made of the influence of sheet thickness on the structure and properties of 06G2AF normalized steel made in an electric furnace (0.06-0.09 % C, 0.16-0.23 % Si, 1.5-1.7 % Mn, 0.008-0.011 % S, 0.005-0.010 % P, 0.16-0.20 % Cr, 0.11-0.21 % Ni, 0.08-0.09 % V) and rolled to sheets 12, 20, 30, 40, 50 and 80 mm thick which were normalized from 950°C with heating in continuous furnaces. The mechanical properties were determined using cylindrical specimens with a gage section diameter of 6 mm. Increasing the thickness of the steel during normalization from 12 to 80 mm is found to cause a decrease in tensile strength and yield point by approximately 15 %, primarily as a result of a change in the formation conditions, dimensions and nature of the distribution of dispersed vanadium carbonitrides in the ferrite matrix, as well as enlargement of the ferrite grain. References 5: all Russian.

6508/9835
CSO: 1842/100

UDC 669.14.018.29

INFLUENCE OF ALLOYING ON FATIGUE RESISTANCE OF 110G13L STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 22-26

[Article by A. P. Popov, Ye. I. Mamayeva, B. M. Levin, T. V. Bodrova, T. K. Kashirina, Central Scientific Research Institute of Machine Building Technology Scientific Production Association; Irkutsk Heavy Machine Building Plant imeni V. V. Kuybyshev]

[Abstract] The problem of increasing the fatigue resistance of type 110G13L steel used for the manufacture of dredge buckets is quite pressing. This article studies the influence of the additional alloying of this steel with vanadium and molybdenum on fatigue resistance and cyclical crack resistance. Steel of the standard composition, steel with 0.6 % V and steel with 0.75 % Mo were fatigue tested in pure flexure. Addition of 0.75 % Mo and 0.58 % V was found to improve fatigue resistance and increase endurance limit from 70 MPa to 105 MPa. The structure of the steels studied has more influence on the length of induction period of a fatigue crack than on its propagation phase. Introduction of 0.75 % Mo causes formation of finely-dispersed uniformly-distributed molybdenum carbides and alloying of the solid solution, leading to an increase in the fatigue resistance of the steel both in the phase before the onset of the fatigue crack and in its propagation phase. References 5: 4 Russian, 1 Western.

6508/9835
CSO: 1842/100

UDC 539.214:669.1'782

INFLUENCE OF ALLOYING ELEMENTS ON DUCTILITY OF HIGH-SILICON IRON

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 27-30

[Article by A. M. Glezer, I. V. Maleyeva and A. I. Zakharov, Central Scientific Research Institute of Ferrous Metallurgy imeni I. L. Bardin]

[Abstract] A study is made of the influence of alloying on the processes of atomic ordering in Fe-Si alloys and on compensation of the negative influence of ductility of the covalent component in the interatomic bond, resulting from an increase in the content of silicon atoms in the solid solution. The problem of selecting an alloying element to increase the ductility of the alloy is significantly complicated by the fact that the unique magnetic properties must be preserved. The ductility, magnetic and structural parameters of alloys of iron with 11 and 12.2 at. % silicon were studied when alloyed with Ni, Co, Cr, Mn, Mo, Nb, Al and Ga. It is found that

addition of Al, Ga, Cr, Ni and Nb increases ductility. A relatively high content of alloying elements results, however, in deterioration of magnetic properties, making small quantities of these elements desirable: 1-2 % Al, Ga, Cr; 1-2.5 % Ni and 0.2-0.5 % Nb. The increase in the ductility of Fe-Si alloys upon addition of Al and Ga results from partial suppression of atomic ordering. The influence of the other elements requires further study. References 7: 5 Russian, 2 Western.

6508/9835
CSO: 1842/100

UDC 620.194.8:669.15.62-272

FATIGUE FRACTURE RESISTANCE OF SPRINGS OF TYPE 50KhFA STEEL AND THE ALLOY 40KKhNMVTYu IN SYNTHESIS GAS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 12, Dec 85 pp 30-32

[Article by V. A. Cheremkhin, Cherepovets Nitrogen FErtilizer PLant]

[Abstract] A study is made of the fatigue fracture resistance of springs made of type 50KhFA steel and 40KKhNMVTYu alloy in synthesis gas and of the influence of heat treatment on the fatigue resistance of these materials in air and in synthesis gas. The springs and steel specimens were hardened in oil and in an aqueous solution of liquid glass with a density of $1.25 \cdot 10^3 kg/m^3$. The structure of 50KhFA steel springs after hardening in oil contains residual austenite; after hardening in the liquid glass solution there is no residual austenite. After hardening of 40KKhNMVTYu alloy in the liquid glass solution, the microhardness of the material changes less through the cross section of the wire than after hardening in oil. The probability of operation without failure in synthesis gas at up to 187°C with 300 loading cycles per minutes increased by 20-25 % after hardening in liquid glass solution as compared to 50XFA hardened in oil. References 2: both Russian.

6508/9835
CSO: 1842/100

UDC 669.183.15-194.2:669.14.018.2

HARDENING OF 22K STEEL BY COMBINED NITRIDING AND VANADIZING

Moscow METALLURG in Russian No 12, Dec 85 pp 19-20

[Article by Yu. Z. Babaskin, S. M. Kutishchev, L. V. Dubenko, I. F. Kirchu, V. I. Kozlov, V. V. Lebedev and V. Ye. Klyucharev, Casting Problems Institute, UkSSR Academy of Sciences, Izhorskiy Zavod Production Association]

[Abstract] An experimental study has established the feasibility of hardening 22K cast steel by the addition of both nitrogen and vanadium in microamounts. Nitrogenated ferrochromium was added to molten steel in the furnace, after the steel had been deoxidized by manganese and silicon, whereupon ferrovanadium was added to molten steel in the ladle. Uniform and stable distribution of the two additives over the metal volume is attainable with 0.1% V and 0.01-0.015% N_2, while the aluminum content must not exceed 0.03% Al. The optimum heat treatment is austenitization at 940°C for complete dissolution of the nitrides, then normalization of tempering after quenching for precipitation and dispersion of the nitrides during cooling. Attendant comminution of the ferrite-pearlite structure increases the tensile strength from 670 N/mm^2 to 750 N/mm^2 and the yield strength from 340 N/mm^2 to 580 N/mm^2 without decreasing the plasticity. The impact strength, 1.9 MJ/m^2 at +20-(-20)°C, decreases only to 1.4 MJ/m^2 at -40°C.

2415/9835
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UDC 669.141.247.2:669.15-194.2.18

REDUCING IRREVERSIBLE LOSSES OF METAL AND ALLOYING ELEMENTS DURING SMELTING OF HIGH-ALLOY STEEL

Moscow METALLURG in Russian No 12, Dec 85 pp 20-21

[Article by A. B. Pokrovskiy, Ts. L. Katsman, L. Ya. Rudashevskiy, V. S. Galyan, B. Ya. Skornyakov, A. M. Shumakov and Yu. A. Radchenko, Zlatoust Metallurgical Plant and Chelyabinsk Scientific Research Institute of Metallurgy]

[Abstract] The technology of smelting high-alloy stainless and high-speed cutting steels such as the 12Cr18Ni10Ti steel in electric-arc furnaces at the Zlatoust Metallurgical Plant was modified in 1983 to reduce the waste of metal and alloying elements in the process. The main change is replacement of silicon as the principal deoxidizer with aluminum production tailings (7-12 kg/ton) and lime (10 kg/ton) so that the silicon content in the alloy drops below 1.0% Si and the aluminum content reaches 0.13% Al prior to decarburization. With the carbon content still 0.15-0.20% C, a mixture of

oxygen and air is blown through the metal while aluminum is being added and the furnace is turned until the metal temperature has risen and the carbon content has dropped to the required level. Aluminum production tailings are further added, together with lime, ferrosilicon, and fluorspar, until a slag sufficiently deoxidized to a high basicity level has formed.

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CSO: 1842/103

USE OF TUNGSTENLESS HARD ALLOYS IN FERROUS METALLURGY

Moscow METALLURG in Russian No 12, Dec 85 pp 39-40

[Article by Z. M. Kuleshevskaya, Special Design-Technical Bureau Orgprimtverdosplav]

[Abstract] Two series of tungstenless hard alloys have been developed by the All-Union Scientific Research and Planning Institute of Refractory Metals and Hard Alloys jointly with the Chemistry Institute of the Ural Scientific Center of the USSR Academy of Sciences. They are based on titanium carbide (TN-20, TN-50) and titanium carbonitride (KNT16, TS30KhN, TS40KhN) respectively. Their main features are high resistance to adhesive interaction during cutting and high resistance to scale formation, their rate of scaling being 10-20 times lower than that of VK tungsten alloys and the coefficient of friction against steel being 2-2.5 times lower. Their wear resistant is not lower than or even higher than that of Sormayt and Relit tungsten alloys. They are used principally for reinforcement of cupping and deep drawing dies and punches in production of steel vessels, also for wire drawing and rope twisting tools. They are formable by chipless methods, most readily by rough grinding with diamond tools or electrolytically and finish grinding with free abrasive powder, usually just like tungsten alloys but in some cases (KNT16) by softer treatment. These alloys are now also being introduced for production of sprocket wheels of crushing machinery and valves of blast furnaces at the Karaganda Metallurgical Combine.

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UDC 621.74:669.14

NICKEL-FREE CORROSION-RESISTANT STRUCTURAL STEEL

Moscow LITEYNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 12-13

[Article by V. T. Ivanov, candidate of technical sciences, and B. I. Aleksandrov, engineer]

[Abstract] A corrosion-resistant steel without scarce nickel but hot-workable, because it also does not contain copper, has been developed for the chemical and food processing industries. Its principal alloying elements, in addition to 18% Cr, are Mn, Al, and B in amounts which have been established in a 2^3-fractorial experiment on the basis of mechanical test data and microstructural analysis. This steel is an austenitic one, with a mixture of chromium carbide and alloyed ferrite along the grain boundaries. The castability of this 20Kh18G9RYu steel (0.18-0.22% C, 18% Cr, 8.5-10.1% Mn, 0.08-0.12% Al, 0.006-0.010% B) is comparable with that of 10Kh18N9TL and 10Kh13G10N3BL nickel steels, with less shrinkage (1.6%) and higher cracking resistance. The carbon content is critical since 0.25% C and above appreciably reduces the corrosion resistance of this steel in a nitrogen atmosphere.

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UDC 621.74:669.245

TEMPERATURE-TIME TREATMENT OF NICKEL ALLOYS IN LIQUID STATE

Moscow LITEYNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 13-14

[Article by N. M. Kochegura, candidate of technical sciences, S. P. Kazachkov, candidate of technical sciences, V. N. Tkach, engineer, and A. S. Vishnevskiy candidate of technical sciences]

[Abstract] Temperature-time treatment of heat-resistant nickel alloys in the liquid state is considered as supplementary means of homogenizing their

structure by more uniformly distributing the 15-20 alloying elements whose combined content reaches 20-30%. Three such alloys (EP 539VD, EP 539LM, ZhS6U) were superheated to a temperature 340-350°C above their respective liquidus points, held at that temperature for 2-3 min, and then cooled to 1560-1540°C and poured into molds for remelting in vacuum furnaces under 0.66 Pa residual pressure. The homogenization temperature was determined from the temperature dependence of their four structure-sensitive properties (density, kinematic viscosity, electrical resistance, magnetic susceptibility). The distribution parameters for each alloying element (especially Ni, Cr, Co, W, Mo, Ti, Al, Nb, Si), namely the ratio of maximum to minimum concentrations and the difference between both referred to mean concentration, were determined from experimental data for quantitative analysis. Such a treatment was found to produce a much more uniform distribution of alloying elements, Cr, Mo, W, Nb, Si being particularly crucial, and in this way to inhibit softening processes at high service temperatures, raise the recrystallization temperature, suppress unfavorable effects of silicon, and facilitate dissolution of niobium. The result is a higher global and local strength of these alloys at higher service temperatures. The treatment is, moreover, very economical. References 2: both Russian.

2415/9835
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UDC 621.74:669.35

HERMETICITY OF CAST COPPER ALLOYS

Moscow LITEYNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 14-16

[Article by L. R. Brontvayn, candidate of technical sciences, and V. N. Gorodetskiy, engineer]

[Abstract] An experimental study of antimony and tin bronzes was made, for the purpose of determining their hermeticity and the dependence of their hermeticity on their chemical composition. These bronzes were produced by smelting in an IST 0.16 induction furnace with acid lining and pressure casting, chill casting, or sand casting. Disk specimens 59-60 mm in diameter and 10-12 mm thick were cut from the upper part of the ladle filled and heated to 300°C for casting in extractable molds. AMG-10 oil was selected as the test fluid and the oil pressure at which leakage or sweating would occur was regarded as the criterion of hermeticity. In one experiment the thickness of specimens was reduced by shaving on both sides in 0.5-.12 mm steps while the oil pressure was held constant, until the critical thickness had been reached. In another experiment the thickness of specimens was held constant and the oil pressure was increased up to its critical level. Analysis of the data has revealed that increasing the Pb content increases the hermeticity and increasing the Sb content decreases it, with neither nickel nor zinc influencing it. The solidification rate during casting was found to be a principal factor determining the hermeticity of those copper

alloys. Most hermetic are BrSu3N3Ts3S20F and Br05S25 with BrSu6S12F, Br05Ts5Sf, Br010S10, BrSu6N2, Br010Ts2, BrSu6F1, Br010S2N3 and Br010F1 less hermetic in that order. The optimum pouring temperatures, for maximum hermeticity, are 1050-1080°C for BrSu3N3Ts3S20F bronze, 1130-1160°C for BrSu6N2 bronze, and 1150-1180°C for Br010S2N3 bronze.

2415/9835
CSO: 1842/90

UDC 621.74.043.2:669.715

LIQUID FORGING OF DIESEL PISTONS FROM ALUMINUM ALLOYS

Moscow LITEYNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 22-23

[Article by A. D. Makagon, engineer, V. N. Platonov, candidate of technical sciences, V. M. Popov, engineer and V. P. Prozorov, candidate of technical sciences]

[Abstract] At the Yuzhdizel'mash Production Association the AK4 low-silicon aluminum alloy has been replaced with high-silicon AL25 or AK21M2.5N2.5 aluminum alloy, to ensure less porosity and better mechanical characteristics of pistons for ChN 12/14 (also 6ChN 12/14, Ch 15/15, Ch 15/18)diesel engines. Conventional casting and chill casting has been replaced accordingly with liquid forging. The facility includes three DB 2436 hydraulic presses and six SAT-0.25 distribution furnaces. A technology has been developed for two piston sizes, 120 mm and 150 mm in diameter, with pouring into ladles done in less than 15 s, forging done under a pressure of 120 MPa or higher, attainable within 5-7 s, and the pressure maintained for this operation for 90 s by means of automatic regulation. Punch and die are designed with a diametral clearance within 0.2-0.5 mm and slant angles of 30'-2°; their temperature is maintained within the 150-250°C range. Molten alloy is poured from a PAT-1 induction furnace at 720-740°C, after it has been refined by means of "Degazer" pellets. A comparative evaluation of the process, with new alloy and liquid forging, indicates a 10-15% longer piston life and a 2-2.5% higher fuel efficiency with 30% less oil lost by burning. Replacement of the AK4 alloy with the AL25 alloy and the change-over to liquid forging should result in an annual cost saving over 2.9 million rubles in production of those diesel engines. References 1: Russian.

2415/9835
CSO: 1842/90

UDC 669.862'25:539.213:538.221

MAGNETIC ANISOTROPY OF AMORPHOUS Gd-Co FILMS NEAR STATE OF MAGNETIC COMPENSATION

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 18 Feb 85) pp 718-722

[Article by G. S. Kandaurova, V. O. Vas'kovskiy, A. A. Kazakov and V. V. Lesnykh, Ural State University imeni A. M. Gorkiy]

[Abstract] Magnetic anisotropy of x-radiographically amorphous Gd-Co films was measured within the range of magnetic compensation. Many specimens of 1 μm thick Gd_xCo_{1-x} films with the chemical composition varied over the $0.17 \leq x \leq 0.23$ range were tested in a rotary anisometer. The anisotropy constant and the saturation magnetization were also calculated from the dependence of the mechanical torque on the magnetic field intensity. The measured perpendicular anisotropy was found to dip to a minimum at the compensation temperature for each Gd-Co composition, the dip becoming sharper with higher degree of homogeneity. Its dependence on the chemical composition was found to be characterized by a deep narrow dip about the $x = 0.20$ point. In the vicinity of magnetic compensation, moreover, the axis of easy magnetization transforms into a cone of easy magnetization, with the vertex angle peaking sharply within the range of the compensation temperature. This transformation is attributable to a surface layer with "plane of easy magnetization" anisotropy. Verification of experimental results by calculations based on the theory of magnetism for a uniaxial ferromagnetic material requires that the sublattice structure in Gd-Co films be taken into account. References 11: 4 Russian, 7 Western.

2415/9835
CSO: 1842/94

UDC 669.3'725:538.214

MAGNETIC SUSCEPTIBILITY OF $Be_{100-x}Cu_x$ ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 6 Mar 85) pp 723-729

[Article by G. Ye. Grechnev and I. V. Svechkarev, Kharkov Low-Temperatures Physical Technical Institute, UkSSR Academy of Sciences]

[Abstract] A study of pure beryllium and two Be-Cu alloys (0.54% Cu, 1.34% Cu) was made, its purpose being to determine the magnetic susceptibility of their single crystals and its temperature dependence over the 77-1400 K range in magnetic fields of 5-15 kOe intensity. The temperature dependence of electrical resistivity was characterized by a ratio $\rho_{300K}/\rho_{4.2K} > 300$ in the case of nearly flawless α-Be single crystals and by a ratio $\rho_{300K}/\rho_{4.2K} \approx 2$ only in the case of Be + 1.34% cu single crystals. Both longitudinal and

transverse components of magnetic susceptibility were measured by the Faraday method, their relative and absolute errors not exceeding ±1.5% and ±2% respectively with a ±1% error of temperature measurement. The experimental data confirm theoretical calculations based on the magnetic susceptibility of pure beryllium $\chi(\mu, T)$ (μ- chemical potential, T- absolute temperature) as consisting of a weak ionic-conductivity component in addition to a spin component and an orbital component contributed by the electronic conductivity. Alloying copper is subsequentlyttreated as an impurity and calculations are based on the scattering effect as well as the De Haas - Van Alfven effect. The authors thank Professor G. F. Tikhinskiy for supplying specimens and Yu. P. Sereda for participating in experiments. References 17: 12 Russian, 5 Western.

2415/9835
CSO: 1842/94

UDC 669-492.3

STRUCTURAL TYPES OF GRAIN BOUNDARIES IN EUTECTIC ALLOY OF γ/γ'-MC SYSTEM PRODUCED BY DIRECTIONAL CRYSTALLIZATION

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 11 Oct 84) pp 751-755

[Article by S. Z. Bokshteyn, Ye. V. Bolberova, S. T. Kishkin, I. N. Roshchina, I. M. Razumovskiy and I. V. Fedina, All-Union Scientific Research Aviation Materials Institute]

[Abstract] The structural state of grain boundaries in eutectic alloys of γ/γ'-phase matrix and monocarbide fibers is analyzed, such alloys produced by directional crystallization and endowed with special favorable grain boundaries, being particularly stable at high temperatures. For an experimental study, an alloy ofthe CoTaC family in the γ/γ'-MC system (γ- solid solution on nickel base, γ'- disperse precipitate of ordered Ni_3Al-type phase, MC- monocarbide) was produced by that process with a plane crystallization front moving at a rate of 6 mm/h. Interphase boundaries were examined in a DRON-3 x-ray diffractometer with a CuK_α source and by radioautography, for crystallographic and boundary identification, in addition to diffusion tests. The results reveal crystal growth in the $\langle 001 \rangle_{\gamma/\gamma',MC}$ direction, with the deviation angle not exceeding 5° within individual grains. The mutual orientation between γ/γ'-phase matrix and monocarbide fibers is $\langle 001 \rangle_{\gamma,\gamma'} \parallel \langle 001 \rangle_{MC}$ $\{100\}_{\gamma,\gamma'} \parallel \{100\}_{MC}$. The principal type of grain boundary is a low-angle one characterized by a low diffusional permeability, with the predominant deviation angle not exceeding 10° relative to the 100 growth axis. It is accompanied by a special type of wide-angle grain boundary with a characteristically high diffusional permeability and with a predominant deviation angle of approximately 37°(53°), also with a high concentration of coinciding nodes $\Sigma = 5$. Grain boundaries of both types have been found to be splitting and joining. References 5: all Russian.

2415/9835
CSO: 1842/94

UDC 621.762.224+666.24.245:669.126.669-157.9

FORMATION OF STABLE STRUCTURE IN POWDER METALLURGY OF NICKEL ALLOYS

Moscow STAL' in Russian No 11, Nov 85 pp 73-77

[Article by M. A. Surikova, V. N. Plechev, Ye. Ye. Nikol'skaya and Ye. F. Yakovleva, Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] A thermally stable structure of nickel alloys produced by hot extrusion of metal powders forms during heating, extrusion, hot rolling, and subsequent heat treatment. A study of two nickel powder alloys of the Ni-Co-Cr-Mo-Al-Ti-Nb group, namely PZhS1 (Al:Ti:Nb = 5:1:2) and PZhS2 (Al:Ti:Nb = 4.5:3:1) with 11.5-12.0 wt.% Al+Ti+Nb each, was made for an examination of their stable structure and of the γ'-phase (Al,Ti,Nb) associated with it. With the aid of an electron microscope and a "Kameka" MS-46 x-ray microanalyzer, there have been established the process conditions necessary for ensuring a technologically adequate plasticity for these alloys and the process conditions necessary for a structure with adequate performance characteristics in service. The results indicate that the best heat treatment for high thermal stability of the alloy structure, a coarse-grain structure, is annealing at the temperature of complete γ'-phase dissolution followed by aging in two stages, first at 850°C for 25 h and then at 750°C for 15 h. Mechanical treatment under conditions of superplasticity will ensure stability of this structure in service. References 2: both Russian.

2415/9835
CSO: 1842/95

UDC 621.762.5

PHYSICOMECHANICAL PROPERTIES OF POROUS FIBER MATERIALS AND THEIR PREDICTION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 14 Jul 83) pp 93-97

[Article by A. G. Kostornov and L. G. Galstyan, Institute of Material Science Problems, UkSSR Academy of Sciences]

[Abstract] Theoretical prediction of properties and technical procedures for assuring their production are of crucial importance when developing new materials. The present article reports on a study of certain properties of porous fiber materials produced from monodispersed fibers of copper, nickel and nichrome. The properties studied were electrical conductivity, tensile strength and the modulus of elasticity. Experimental and theoretical values were compared. Results indicated that electrical conductivity can be calculated on the basis of a model for a porous body as a system of infinite chaotically oriented cylinders, and is in an inverse

relationship to the percentage of porosity. Tensile strength and the modulus of elasticity could also be projected, and were found to increase as density of the finished product grew. References 7: all Russian.

12131/9835
CSO: 1842/101

UDC 621.762

STRUCTURAL FEATURES OF SOLID ALLOYS BASED ON TITANIUM CARBIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 11 Jan 84) pp 98-103

[Article by N. N. Sereda, M. S. Koval'chenko, V. T. Bondar',
L. N. Beloborodov, V. A. Tsyban, B. I. Markhasev, and V. I. Poznanskiy,
Institute of Material Science Problems, UkSSR Academy of Sciences]

[Abstract] Shortages of tungsten and cobalt bring increasing importance to the study of substitutes such as titanium carbide with nickel-molybdenum bonding agents. The present article reports on the structure and physico-mechanical properties of hard alloys of the KTS type, produced by cold pressing and subsequent sintering in a vacuum at various temperatures. Alloying agents and the dispersion of carbide particles varied. The resulting specimens were examined with optical and electron microscopes and by local X-ray spectral analysis. Results indicated that the microstructure of the alloys formed with participation of the liquid phase and was accompanied by recrystallization and coalescence of carbide granules. Their growth was observed as sintering temperatures increased and finely divided granules (less than 1 or 1-2 μm) of titanum carbide were introduced. Intra- and intergranular failure, quasi-spalling and other points of bonding failure are discussed. Results indicated that the alloy labeled 2M4, sintered at 1420-1520°C and with granules of 1.8-4.8 μm, had greater durability and less tendency for the growth of carbide granules than other variants. Failure varied for the different alloys, 2M2 failing by breaking, 2M3 by spalling and 2M4 by a combination of indentation and breaking. References 9: 8 Russian, 1 Western.

12131/9835
CSO: 1842/101

UDC: 669.28:532.6

CHANGE IN SURFACE OF NIOBIUM PENTOXIDE AND HEMATITE UPON SUBLIMATION IN AN INERT ATMOSPHERE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 5 Dec 84) pp 4-6

[Article by Ye. Yu. Zamalin, G. Ya. Meshcheryakov, All-Union Correspondence Machine Building Institute]

[Abstract] A study is made of the sublimation of partially dissociable Nb_2O_5 and fully dissociable Fe_2O_3. The evaporation of Nb_2O_5 and hematite was experimentally studied in a current of helium at various temperatures, measuring the surface area of the powdered oxide by low-temperature adsorption. The activation energy of the process of changing surface area was determined for sectors where the temperature change was monotonic. The mechanism of evaporation was found to consist of several elementary stages. For Nb_2O_5: movement of atoms of oxygen and niobium to the surface into the adsorbed state; migration of atoms over the surface to form O_2 and NbO_2 as a result of active collisions; desorption of molecules from the surface and diffusion of the molecules into the gas phase. The limiting stage is apparently the surface diffusion of O or Nb. For hematite: dissociation of the Fe-O bond; diffusion of iron atoms into the crystalline lattice and movement of oxygen atoms into the adsorbed position; migration of oxygen atoms over the surface to formsoxygen molecules; desorption of oxygen molecules from the surface. The limiting stage is apparently the desorption of oxygen from the surface of the oxide. References 6: 5 Russian, 1 Western.

6508/9835
CSO: 1842/106

UDC: 669.187.083.4:541.122

THERMODYNAMIC CHARACTERISTICS OF VACUUM TREATMENT OF NICKEL-MANGANESE MELTS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 3 Jan 85) pp 34-37

[Article by Yu. V. Balkovoy, R. A. Aleyev, V. A. Grigoryan and V. K. Bakonov, Moscow Steel and Alloys Institute]

[Abstract] A study is made of the thermodynamic characteristics of the nickel-manganese system. The distillation factor of manganese can be used to estimate the relative losses of nickel with a fixed degree of demanganation. A figure illustrates the calculated data. Upon evaporation of elements under diffusion conditions, the Olette equation, which can be used to estimate the

relative loss of nickel, is suitable for calculation of relative losses of all components if the change in distillation factor with time of holding is considered. A semi-empirical equation is suggested for calculation of the distillation factor of manganese from nickel as a function of the initial composition of the alloy and holding time. References 5: 4 Russian, 1 Western.

6508/9835
CSO: 1842/106

UDC: 669.29:539.67

INFLUENCE OF SUBSTITUTION IMPURITIES ON MODULUS OF NORMAL ELASTICITY OF NIOBIUM

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 23 Jan 85) pp142

[Article by V. Ye. Bakhrushin, A. V. Novikov and Yu. A. Pavlov, Moscow Steel and Alloys Institute]

[Abstract] A study is made of the influence of tungsten and hafnium on the elasticity modulus of niobium. Specimens used were foil strips 0.1 mm thick, preliminarily annealed at 2400-2600 K in a vacuum of $2 \cdot 10^{-3}$ Pa for one hour and then hardened. In the 300-650 K range the elasticity modulus is practically independent of temperature in all alloys studied, while at 650-800 K there is a minimum in the curve as a function of temperature related to the relaxation of nitrogen atoms in this temperature interval. The variation of the elasticity modulus as a function of W and Hf content agrees well with the concept of the influence of alloying by elements of groups IV and VI on the nature of interparticle interaction in niobium. References 2: both Russian.

6508/9835
CSO: 1842/106

UDC 620.17:669.24'28

INFLUENCE OF GERMANIUM AND PRODUCTION METHOD ON MECHANICAL PROPERTIES OF NM23KhYu ALLOY AT HIGH TEMPERATURES

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 32-35

[Article by D. V. Lebedev and V. M. Rozonova, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] The purpose of this study was to increase the ductility and toughness of NM23KhYu alloy without deterioration of its usage properties, to select methods for evaluating ductility and toughness at elevated temperatures and to establish an optimum hot pressure treatment temperature range on the basis of the results. Pilot-scale production of the alloy was performed in a vacuum-induction furnace. Alloying with germanium is found to result in an increase in impact strength by a factor of 2 to 3 at 900-1200°C. Electron-beam remelting with germanium increases impact strength at 800-1200°C by a factor of 2 to 3 and the ductility characteristics at 1100-1200°C by a factor of 1.5-2 in comparison to the analogous properties of the alloy obtained by vacuum induction melting. Flexure testing showed no differences in ductility of the electron beam remelted and vacuum induction alloys at 1100-1250°C. Hot pressure treatment of the alloy with germanium should be performed at 1160-1180°C.

6508/9835
CSO: 1842/100

UDC 621.78:669.295.5

INFLUENCE OF COOLING MODES IN HEAT TREATMENT ON MECHANICAL PROPERTIES OF VT3-1 TITANIUM ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 36-38

[Article by M. Ya. Brun and L. A. Bykova, All-Union Light Alloys Institute]

[Abstract] Since the cooling rates of actual semifinished goods with different cross sections vary broadly, there is interest in a study of their influence on the mechanical properties of VT3-1 alloy and in a determination of the cooling rate providing a globular-plate structure with a controlled ratio of the amount of globular and plate α-phase α_{gl}/α_{pl} = (20-30/70-80)% to achieve the optimal combination of mechanical properties. The properties of rolled bars 18 mm in diameter of types 1,2 and 9 according to the standard scale from two series of melts were tested. Various rates of cooling from 920-960°C (0.003 to 45°C/s) were used. Heat treatment was followed by mechanical testing and microstructural analysis of the specimens.

It was found to be desirable to test the microstructure of (α+β)-titanium alloys before heat treatment. Heat treatment can then be made more effective as a means of effecting mechanical properties. In order to produce the desired ratio of globular to plate structure, the cooling rate should be 0.5-1.0°C/s. Slower cooling causes an increase in globular fraction, while faster cooling causes a decrease in fracture toughness characteristics. References 5: all Russian.

6508/9835
CSO: 1842/100

UDC 669.295:620.17.172

VACUUM ANNEALING OF VT3-1 ALLOY BLANKS AFTER ISOTHERMAL DEFORMATION USING HYDROGEN PLASTICIZING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 38-41

[Article by V. K. Nosov, I. A. Pavlov, S. B. Belova and L. V. Andreyeva]

[Abstract] The purpose of this work was to select and substantiate conditions for vacuum annealing of preliminarily hydrogenized billets of VT3-1 titanium alloy so as to decrease the hydrogen content to permissible values and produce the necessary mechanical properties after isothermal deformation using hydrogen plasticizing. Analysis of the distribution of hydrogen through the cross section of the specimens showed that after vacuum annealing the mean hydrogen content in the alloys corresponded with that calculated using equations presented in the article. Increasing the vacuum annealing temperature decreases the mean hydrogen content. Vacuum annealing of titanium alloys with high hydrogen content should be performed at 750-850°C. The use of hydrogen plasticizing during isothermal stamping with subsequent vacuum annealing results in an increase in ductility and impact strength, an some decrease in strength, without influencing bend angle or endurance limit in pure flexure, The use of preliminarily hydrogenized billets helps to improve force conditions during operation of the dies. References 7; all Russian.

6508/9835
CSO: 1842/100

UDC 539.3

DEVELOPING A FUNCTIONAL OPTIC ILLUMINATOR REPORT 1

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 85
(manuscript received 10 Nov 84) pp 104-109

[Article by I. I. D'yachkov, A. L. Kvitka, . . V. Komyagin and
V. S. Morganyuk, Strength Problems Institute, UkSSR Academy of Sciences,
Kiev]

[Abstract] The technical needs of hydrooptical experiments urgently require new designs for functional, dependable illuminators made of inorganic glass and quartz. The present article reports on the evaulation of the design strength of plane disc optical illuminators made of various inorganic glasses and quartz and a study of the load bearing, operational and strength properties of the new optic angle. Stable optical properties were required of all tested illuminators. The glass-metal contact zone, known to be the typical point of failure, was studied with great attention. Three structural designs were tested. Stress and strain features for the most functional shape, a cylinder with a ring-shaped reinforcing surface, were found to be satisfactory under hydrostatic pressure. Other tested designs were judged unacceptable. References 7: all Russian.

12131/9835
CSO: 1842/102

CASTINGS SUPPLY FOR MACHINE BUILDING REVIEWED

Moscow EKONOMICHESKAYA GAZETA in Russian No 42, Oct 85 p 12

[Article: "The semifinished article base for machine building" under the rubric: "A technical and economic review"]

[Text] In the decree of the CPSU Central Committee and the USSR Council of Ministers on the machine building industrial complex, special attention was given to strengthening the semifinished article service and auxiliary shops of enterprises. This applies directly to foundry production, the technical level of which directly affects the quality of machine building and other important products.

In the foreseeable future, foundry production will remain a principal semifinished castings source for machine building. Also, the construction materials, ferrous metallurgy, and other industry branches cannot do without castings.

The overall volume of the production of foundry equipment in the USSR is commensurate with the volumes of its production in the countries which are most highly developed technically. A comparison, however, of the volume of equipment production in relation to the output of castings indicates a need to improve this relationship. As seen from world trends, our machine builders have available large reserves for lowering the unit expenditure for casting per million rubles of commodity output. The 12th Five-Year Plan should become a turning point in this relationship.

Of paramount importance is a substantial improvement in the working quality of cast parts, an increase in their accuracy, a reduction in metal consumption and improvement in strength and other mechanical properties. In foundry production itself, the most important problems are: sharply raising the productivity of labor, the level of mechanization and automation of all production divisions, and curtailing the unit consumption of raw metals, coke, moulding materials, and electrical energy.

The Effect of New Technologies

All this will be achieved by the introduction of new technologies for casting,

purposeful and comprehensive technical reequipping, and the development of concentration and specialization in foundry production.

Specialists consider that, first of all, the structure of the production of castings should be improved. In prospect is an increase by a factor of 2-4 and more in the production of castings made from high-strength cast iron, in the transition to which, the weight of castings is reduced by 8-12 percent in comparison with those made from steel and by 15-30 percent in comparison with billets made from grey cast iron. The replacement of steel castings with high-strength cast iron, in addition, saves energy resources. Actually, the energy consumption of cast iron casting production is half as much as for steel casting production.

In all branches of machine building the volume of the production of precision castings obtained by efficient special casting methods will grow substantially. The special methods involve: meltable patterns, casting under pressure, casting in a metal mould, centrifugal and continuous casting, and casting in shell moulds. Vacuum-film moulding will receive widespread use.

The use of such technologies will save up to 300 kilograms of metal for each ton of castings, will sharply curtail the amount of the least mechanized and most labor consuming cleaning and trimming operations, and will lower the machining allowances by 30-90 percent. According to specialists' calculations, several million tons of metal can be saved on the basis of the increase in the geometrical and w ight accuracy of castings, the reduction of wall thicknesses, and reducing allowances. Each ton of precision castings will save 1.5-2 tons of rolled stock.

The combination of precision casting with the use of high-strength alloys gives the greatest gain. The cost of castings made of high-strength cast iron by the meltable pattern method is less by 10-20 percent than stampings or castings made by traditional methods.

Enterprises of Minstankoprom [Ministry of the Machine Tool and Tool Building Industry] are assimilating the progressive technology of manufacturing precision cast iron articles for parts of hydraulic equipment having cast ducts of small diameter and great length. This sharply improves the quality, reduces the dimensions of the hydraulic equipment, and lowers the amount of subsequent machining by many times.

The Kashira Tsentrolit plant, in the first half of the current year manufactured 1,500 tons of such castings with an assignment of 1,200 tons. It has achieved stable production. There is another picture at the Rustavi Tsentrolit plant. For a long time the enterprise has not coped with mastering production of the progressive castings, and does not fulfill assignments for smelting blanks from high-strength cast iron. There are many grievances from clients about the quality of the products of Rustavi Tsentrolit.

While in the Minavtoprom [Ministry of the Automotive Industry], for instance, according to specialists the proportion of castings obtained by use of progressive technological processes is three quarters, in Minselkhozmash [Ministry of Tractor and Agriculutral Machine Building] - a sector with practically the same kind of production - that indicator reaches only 47.5 percent, and in Minelektrotekhprom [Ministry of the Electrical Equipment Industry], it is only 43 percent.

In Minavtoprom, in the total volume of cast iron casting, casting from high-strength metal has reached almost 8 percent, but in Minselkhozmash it amounts to only 2.7 percent. Enterprises of Minzhivmash [Ministry of Machine Building for Animal Husbandry and Fodder Production] generally have not assimilated the production of such progressive castings. As to industrial sectors having only a medium or small amount of serial production, Mintyazhmash [Ministry of Heavy and Transport Machine Building] has brought the production of castings from high-strength cast iron up to 3.2 percent, Minenergomash [Ministry of Power Machine Building] - to 2 percent, and in Minstankoprom it amounts to 1 percent.

The high index of usage by Minavtoprom is as result of an active, purposeful engineering policy. There, over 4 of the 5 years of the Five-Year Plan a reequipping has been done of more than 100 foundry shops on the basis of introducing progressive technologies and high-productivity automated equipment. At the Gorkiy motor vehicle plant for instance, automatic moulding lines are successfully replacing obsolete foundry conveyors. Each line frees from 26 to 40 moulding operators and is beginning to operate with the designed productivity after only two weeks and doesnot require stopping production.

Reliability and Economy

An urgent problem confronts machine builders and foundrymen; namely, to raise the reliability and freedom from failure of equipment.

Many new production lines and complexes are being delivered by Minstankoprom, unfortunately, without primary equipment - without the moulding boxes for automatic production lines, without the metallic forms for machine casting under pressure and in a metal mould, without attachments for the manufacture of rods which harden in the equipment, and without other means. This has a negative effect on the time for placing equipment into operation and reduces the economic gain from its use.

The organization of special production of machining attachments for foundry equipment and the providing of complete sets of it for newly manufactured lines and modules is an indispensable requirement and condition for raising their technical level and efficiency. Minstankoprom's task is to find ways to accelerate the solution of this problem.

In the manufacture of castings, in addition to the metal itself, large amounts of smelting stock and moulding materials, coke, gas, and electrical energy are expended. To obtain one ton of satisfactory castings requires 1.2-2 or

more tons of smelting material, approximately 190 kilograms of coke, and from 3 to 20 tons of moulding materials. Moreover, 1.2-1.4 tons of waste products are formed. It should be noted that the unit consumption of fresh melting and moulding materials at many enterprises sometimes is twice as high as in the best domestic or foreign casting shops.

At the Moscow Stankolit plant an automated cupola complex with an extended continuous work cycle in a high-temperature regime was put into industrial operation. In the first half of the present year there, 16,500 tons of cast iron were smelted with a planned assignment of 15,000 tons. The use of this complex reduced the loss of metal by burning from 5-6 percent to 2-3 percent, and curtailed the consumption of blast furnace pig iron by 26 percent.

Foundry production now requires up to 20 billion kilowatt hours of electrical energy per year. It therefore is very urgent to develop and introduce technological processes which lower electrical energy consumption per ton of finished castings by 100-200 kW-hr.

The improvement of the energy-intensive of smelting processes opens up large potentials for saving; for instance, the production of cast iron castings from ferrous metal scrap in electric furnaces, in modern cupola complexes, or by the duplex process. A two-row arrangement of the tuyeres of cupola furnaces and heating the blast saves up to 40 percent of coke. The use of plasma-induction smelting reduces the consumption of energy by 20-25 percent compared to induction smelting.

Wasteless Methods

A very promising direction for a transition to wasteless foundry production is the regeneration of moulding materials from the worked-out mixtures of foundry production, and expansion of the production of enriched moulding sands. At present the basic plant layouts and installations are being developed. As the practices of advanced enterprises show, expenditures for regeneration including the costs of the equipment, are recovered in 2-3 years because of sharp reduction of haulage, stabilization of technological parameters, and the saving in fresh sand. Not less important is the fact that in so doing, railroad transportation is markedly relieved, and the ecology is improved.

In the 12th Five-Year Plan, the development of foundry production must provide for no increase, and even a decrease, in the use of moulding sands and certain other materials.

In order to achieve this, the foundry machine building plants of Minstankoprom must organize in the needed volume complete complexes of production equipment satisfying every scale of foundry production. The introduction of the regeneration of sand becomes an integral and obligatory part of all projects for the modernization and technical reequipping of every foundry shop.

The centralized manufacture of cast semifinished articles will increase substantially. Scores of small, uneconomic shops and sections will close. These measures taken by all the machine building ministries, should lead to a substantial increase in the degree of comprehensive mechanization and automation of foundry production and to the elimination of hand labor on heavy and dangerous operations.

Special attention should be given to sharply raising the technical level of production in small shops account for up to 70 percent of the range of castings. The achievements of scientific and design conceptions in this field open up broad possibilities for the transformation of each foundry shop and section into a highly profitable and modern production unit in the level of applied technology and labor conditions.

The solution of all these complex problems requires the energetic work, first of all, of the enterprises of the VPO [All-Union Production Association] Soyuzlitmash. Unfortunately, in the work of this association there still are large deficiencies. The target for the three quarters for the production of foundry equipment has not been fulfilled. More than a fourth of the whole production is done in the last days of the month. Siblitmash disrupted the schedule for delivery to Rostselmash and, in Ivano-Frankovsk, Avtolitmash delayed the realization of the orders of the Kalinin and Ryazan Tsentrolit plants.

In the acceleration of scientific and technical progress in foundry production a decisive role belongs to the scientific organizations of the machine building sectors, to the scientific production associations, to the concentration of their efforts on the main problems, and to the precise coordination of their activities. In Minstankoprom, however, - the industrial sector called upon to determine the technical policy in foundry production for all machine building of the country - the development of its own foundry establishment mainly has been allowed to run of its own accord. The institutes and design and technological organizations serving the foundrymen are dispersed among various administrations and VPO are practically left to their own devices in the selection of the directions and subjects of their own developments.

Elimination of these and other deficiencies to bring foundry machine building and then foundry production to the most advanced position in the world is a matter of honor for the scientific research, planning and design, and production collectives. The decisions of the Party and the Government on the machine building industrial complex require a new approach to the technical level of the semif nished billet base for machinebuilding.

9136
CSO: 1842/91

PIPE PLANT PRODUCTION PROBLEMS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 4 Dec 85 p 2

[Article by special correspondent D. Melikov: "A Question without an Answer" with subheading: "Reports and Elections in Party Organizations"]

[Text] Sumgait. The Azerbaijan Pipe Rolling Plant imeni V. I. Lenin is one of the principal suppliers of pipes in the assortment for the petroleum industry. Drilling, geological exploration, and casing pipes produced at this plant are intended for the oil fields of Western Siberia and the Tyumen oblast and other oil and gas producing regions of the country. Opinion about the plant's output is unanimous - it is of low quality. The joyless results of the work of the collective during the 11th Five-Year Plan are that the oilmen of the country have not received tens of thousands of tons of pipe of the petroleum assortment, and the indicators of deliveries according to agreements over these years have not once been raised above 94 percent.

A day or two ago, a report and election Party conference was convened here. In what does the almost 2,000-strong detachment of communists of the Pipe Rolling Plant see the reasons for their failure? Here is how the delegates to the Party conference evaluate the situation.

The plant director, E. Pashayev:

"The reasons are many. But the principal reason is a chronic under-delivery of steel-making pig iron. Because of interruptions of pig iron alone, we annually stand idle for several weeks. And yet one must admit that in this five-year plan we ourselves worked wretchedly. Blinded, apparently, by the somewhat improved indicators of operations in the present year, a complacent mood came to some of our comrades. The open-hearth shop, for instance, fulfilled the plan thanks to the selfless work of the steel makers of three open-hearth furnaces out of six operating. Because of of smelting delays alone, 14,000 tons of metal were under-produced. Because of a lack of refractory materials through a fault of the supply department, we did not receive a great amount of steel. And the chief mechanic's service did not keep within the planned schedules for repairing open-hearth furnaces. There were large above-normal idlenesses in the rolling and pipe shops. All this led to curtailing the output of the final product, and to a constant arrnythmia in the operation of the enterprise."

The director's speech to the Party conference was sharp. He has been director at the pipe rolling plant about a year. Over this time he succeeded in many ways in putting the place in order. For the first time over the years of the Five-Year Plan, the AZT [Azerbaijan Pipe Rolling Plant] reached the level of the annual plan, and 12 percent of the pipe is graded with the State Mark of Quality. A schedule of deliveries of pipe to Western Siberia and Tyumen oblast has been made up and, at last, is being strictly observed. On the 25th of December the plant will completely fulfill the annual deliveries of its products to these regions. Nevertheless, the conference acknowledged the unsatisfactory work of the commission of the Party Committee in monitoring the contracted deliveries.

The situation at the plant must change and, first of all, the communists must improve their work. Each at his work place must honestly, and with full output, toil conscientiously and be concerned with his work. No more, no less. It is time to change from a statement of deficiencies, from numerous consultations and futile recommendations to another formula and style of work. He who does not wish to improve, or be concerned with the business, he who does not feel responsibility? - for that one what must be called to order. This touches everyone - from worker to director. Such a statement of the problem was warmly supported by the overwhelming majority of the delegates of the conference.

Ya. Abbasov, Party Group Organizer, steelmaker of the open-hearth shop, and Deputy to the Supreme Soviet of the Azerbaijan SSR:

"Why are representatives of the main administration of the VPO [All-Union Production Association] Soyuztrubostal and the USSR Ministry of Ferrous Metalurgy not present at our conference? The Party Committee invited superintendents to take part in the discussion on how to help the communists of the enterprises in coming out of the prolonged stagnation. The oilmen charge us with producing poor pipe. Their grievances are substantiated. But can good products be produced on equipment which has been in use for more than 30 years already? How many times we have asked Minchermet [Ministry of Ferrous Metallurgy] for assistance in a transition to electric-furnace steel smelting, and to continuous casting of steel which guarantee high-quality products corresponding to world standards? There is no response at all! While investing kopeks in maintenance of scarcely breathing equipment for the basic production, Minchermet is not stingy in financing the final finishing subdivisions. Much imported equipment has been bought for the manufacture of pipe couplings and threaded connections. But the pipes themselves don't correspond with the connections and couplings. Such an "unequal marriage", in essence, gives a microscopic improvement in quality while not solving the problem as a whole. It turns out that we are "varnishing" the external appearance of the pipe while its quality remains low. It is naive to suppose that such a product will withstand formation pressure. It is true that in Minchermet they have promised to add to the magnificent finishing production line a new line for producing casing pipe, thus closing the technological circuit.

"For this new production line we have struggled for four years already. All was arranged - the technical substantiation, the design, Minchermet agreement, negotiations took place with the company - then, suddenly we learned that our production line had been transferred to the new Pervouralsk pipe plant. Such a step by Minchermet and PVO Soyuztrubostal is at least incomprehensible and is economically inadvisable - actually, at Pervouralsk, there is no finishing subdivision similar to ours.

"We will deliver to the oilmen poor pipe with outstanding couplings and the Pervouralsk people will deliver noteworthy pipe with poor connections. The compromise decision of Minchermet compels us to think about the prospects for our plant with great alarm. On the 1st of January 1987, a new, more rigid GOST [State Standard] for pipe production will be introduced. For us, this GOST, in a word, is a verdict. There will be a reduction by almost one half in the output of the product. When will Minchermet take decisive steps and finally become really occupied with the problems of the development of the plant ? It appears that workers of the PVO and Minchermet consciously refused to come to Sumgait. What could they say to us, to communists, to the whole collective?"

Steelmaker Yashar Abbasov is right. With the development of deeper oil and gas strata and the intensification of the production of oil and gas, the requirements for the metal and the pipes for the oilfield assortment have increased sharply. The existing technology, however, for smelting, pouring, and rolling steel does not permit achieving an improvement of quality without conducting a radical reconstruction of the metallurgical cycle. Meanwhile, in Azerbaijan there are important prerequisites for a transition to a higher level of metallurgical production. Here is the largest Trans-Caucasian energy base, and it will be further developed by the construction of a nuclear electric power station. Here is the largest potential in the region for scrap formation, a powerful fuel sector, and also available labor resources and highly qualified cadres of metallurgists.

How can such potential not be used? This question was posed at the Party conference of the Azerbaijan Pipe Plant. It will have to be answered.

9136
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NEW HEAT TREATMENT PROCESS FOR CASTINGS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 4 Dec 85 p 4

[Article by Academician A. F. Belov: "Prolonging the Life of Parts"]

[Text] Millions of tons of castings of cast iron and steel, aluminum and titanium, of copper, nickel, and other alloys are now obtained by the method of shaped casting. Its advantages are indisputable - the poured metal is able to fill practically any form; hence it can be used to manufacture those semifinished castings for machine building which, by other methods, either is not done generally, or they require excessive labor and material consumption. Unfortunately, the deficiencies of the method are well known. During crystalization of the metal, its internal structure is low-density and coarse grained, and so-called shrinkage defects are formed in the casting. Foundrymen long have dreamed of eliminating these imperfections. Scientists have developed a number of new, progressive methods of casting; but all the same they, equally, have been unable to eliminate defects completely.

But today, a practicable technology can be named for obtaining castings whose properties closely approximate the high qualities of worked metal and sometimes even exceed it. It is VGO - high-temperature gasostatic processing. Imagine a chamber filled with some neutral pre-heated gas, argon for instance. In this closed space, high isostatic pressure and temperature act on the cast article, "healing" the casting defects provided they do not appear on the surface of the semifinished casting. Under the action of this "medicine", large and dispersed microdefects disappear.

Numerous experiments showed that the plasticity of the metal in castings made from various alloys is increased as a minimum by a third, and sometimes by a factor of two. The life of semifinished castings processed by the VGO method increases sharply, and prolonging the service life of a part is just the same as increasing the output of the product. And the expenditures in this are less by a factor of ten than the investments necessary to expand production. In a word, High-temperature gasostatic processing opens vast possibilities in machine building. From the same metal which today goes into shaped castings, essentially, twice as many castings can be obtained, taking into account, of course, the increase in service life.

But this does not exhaust the spectrum of the merits of the new technology. VGO improves weldability, the uniformity of mechanical and chemical treatment, and increases the vacuum-tightness of castings. The method makes practicable the replacement by precision shaped castings, of some uneconomical stampings which characteristically have a low coefficient of utilization of metal and a high labor consumption in machining. Finally, the "therapy" in the gasostat affects the quality of welds positively.

By the way, the word "therapy" can perfectly well be used without quotation marks when we speak about VGO. The gasostat restores worn out parts which operate mainly at elevated temperatures, for instance, the vanes of gas turbine engines. Micropores formed during operation, which are potential sources of failure, disappear, and the part can well be operated for one more period.

It is clear how important it is that high-temperature gasostatic treatment be transferred as rapidly as possible from the laboratory to plant shops. The gasostat must become an inalienable appurtenance of new metallurgical and machine building plants - actually it is able to provide high-quality castings, to increase the life of metallic semifinished articles and structures, to raise the coefficient of the utilization of metal, but, mainly, to improve the quality of semifinished articles shape-cast from complex high-strength and heat-resistant alloys.

Can the production of gasostats having various dimensions for the working chamber be difficult to master? It is not. These are rather simple devices and any enterprise specializing in the production of metallurgical equipment can manufacture them. It is impossible to delay, otherwise the time can be lost. Abroad, right now, about 50 gasostats are going into operation annually, and a number of firms have mastered their series production.

The new technological process of high-temperature gasostatic treatment, without question opening up an efficient way of raising quality and reliability, in the 12th Five-Year Plan should pave the way into the plant shops.

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WAYS TO SAVE FERROUS METALS OUTLINED

Moscow SOVETSKAYA ROSSIYA in Russian 12 Dec 85 p 1

[Article by S. Yefimenko, Deputy Chairman of the USSR State Committee for Science and Technology, under the rubric "Discussion before the Congress: Commentary on the Figures of the Basic Directions: "Metal's Second Life: To Save 12-14 Million Tons of Rolled Ferrous Metal"]

[Text] In carefully reading the draft of Basic Directions, each of us primarily dwells on the points which affect his professional and private interests. But there are statements that pertain to literally everyone. These are questions of economy and thrift. The document names economy as one of the most important factors in intensifying production. Which is understandable: By effective management, the same raw material can produce considerably greater output.

Saving metal is especially important. The scale on which it is produced determines the technical and economic level of any country. In other words, the more metal a state produces, the stronger its economy, the stronger its defense capacity. Therefore, at one time the main concern of the country, which had to depend only on its own strengths, was production of as much iron and steel as possible. We achieved our goals--we assumed world leadership in output of ferrous metals.

Unfortunately, in the dust raised by concerns about quantity indicators, metallurgists have not always remembered quality and have shown little concern about adequate output of steels with improved properties. What has been therresult? Increased metal consumption: For an item to have required strength, it has to be more massive, or, as specialists say, more metal-intensive. Second, an abundance of metal unwittingly created an extravagant attitude in users.

A short animated cartoon recently shown on television comes to mind. A business-like man in worker's overalls heaved a huge blank onto a lathe and turned on the motor; the entire screen quickly filled with chips. The part which the hero of the tape finally machined was--a tack. It was needed to hang a poster that said "Save metal!"

Of course, one can laugh at the subject: They've given it a twist... However, let's look at statistics. The country's 11 machine-building ministries produce wastes equal to more than one-fourth of the ferrous metals they are allocated for producing goods. Almost half of the wastes are chips. The metal turned into chips could satisfy the annual needs of several ministries. It could be used to produce thousands of tools, lathes, and machines for the light and food-processing industries and for power plants.

Can the situation be corrected? Without question! Soviet science and technology offer highly economical, advanced methods to produce, work, and use metals. For example, a method developed by Soviet scientists for continuous casting of steel permits metal savings of 10-12 percent. Higher output of finished goods than in traditional production also results from such progressive techniques as processing outside the furance, bottom flowing in converters, electroslag refining, and electric furnace steel smelting. But these technologies are valued not only for savings in the first process stage. They make it possible to produce metal with improved quality and with the required properties, and, as a result, the goods produced are reliable, strong, and long-lasting. This means that it is possible to save metal both during manufacture and during machinery operation. For example, having used a new instead of an obsolete grade of steel in excavator designs, Uralmash workers are now annually saving hundreds of tons of metal. In addition, machinery made of high-quality metal breaks down less often and requires fewer spare parts. This is no small change. More than 20 million tons of metal are consumed annually in our country to maintain machinery and equipment in working condition.

Progressive processes for producing blanks and parts offer great opportunities for savings. For example, we know the advantage of using rolled products instead of cast steel. Use in machinery designs of efficient shapes which approximate to the maximum the shape and sizes of the finished parts minimizes machining and, consequently, metal consumption. Reducing the proportion of metal-cutting technologies in machine-building, switching to production of parts by precision stamping methods, powder metallury, etc. achieve the same result.

An obvious example of this the techniques and equipment developed by the collective of the VNIIMetmash (All-Union Research Institute for Metallurgical Machine-Building) Scientific Production Association. On special lathes, a heated and softened blank receives the required shape, and the part is virtually finished. Only in certain cases is minimum finishing required. Use of such techniques makes it possible to increase the metal utilization factor 1.5-2 times. And if we calculate the effect of all processes and measures which result in savings! Their implementation in tractor-building alone will permit a savings of more than a half ton of metal for each machine. Multiply this by 500,000 tractors--the quantity the country produces annually.

Unfortunately, we have to admit that ferrous metallurgy has still not managed to create the required capacity to produce progressive types of metal products, and the machine-builders to reorganize work at their own enterprises. We lose metal even in the first stages of metallurgical production. For example, to obtain a ton of finished rolled product, metallurgists use 1,200-1,250 kg of molten steel. However, this indicator does not exceed 1,080-1,100 kilograms at the country's best plants. It also happens that rolled product obtained from the same steel grade has entirely different strength indicators. What's the result? That, when creating machinery, designers insure themselves: knowing that rolled product with minimum strength might turn up, they provide for more massive parts and assemblies in their calculations. Now and then, more than twice as much metal has to be used where there is no need whatsoever. As a result of all this, when bridge cranes, certain brands of trucks and cars, refrigerators, and other goods are manufactured, we use 20-25 percent too much metal.

In the machine-building industry, as before, blank production is being restructured slowly, and the proportion of waste-free and low-waste processes is barely increasing. This results in high metal losses. This relates primarily to enterprises of the Ministry of Tractor and Agricultural Machine-Building and the Ministry of the Automotive Industry.

Backward labor organization, ingrained habits, and old design standards stand in the way of steels with improved properties, progressive rolled shapes, and other metallurgical innovations which would help save many tons of metal.

It is obviously time to combine the problems of producers and users in a single system, in which the schedules and optimum ways to improve quality and efficiently use metal would be specifically defined.

Of course, measures are being taken to correct the situation, and in time they will have the required effect. However, now, when we are solving the complex problem of accelerating the country's social and economic development, an evolutionary approach is useless. The agenda includes problems of the basic restructuring of industrial production and its renewal on the basis of the achievements of scientific-technical progress. We have approached the development of the program for the technical re-tooling of ferrous metallurgy precisely from these positions. Specialists from the State Committee for Science and Technology, USSR Gosplan, the Ministry for Ferrous Metallurgy, and the USSR Academy of Sciences are involved in its creation. By their decrees the CPSU Central Committee and the USSR Council of Ministers have ratified this program. The draft Basic Directions states, "Accomplish the projected program for reconstructing and modernizing metallurgy."

Nevertheless, this industry program is only part of what can be done for the effective use of ferrous metals. This problem can be most completely solved within the framework of an integrated inter-industry "Metal Intensiveness" program, which must have nationwide status. Development of such a program is an urgent necessity today. In addition to the renewal

of ferrous metallurgy, problems of elevating machine-building to a new level, fundamentally improving matters in capital construction, and many other problems must be solved. Workers of the State Committee for Science and Technology, together with USSR Academy of Science scientists and specialists of the Ministry of Ferrous Metallurgy and the machine-building ministries, have developed the detailed concepts of this program. They take into account virtually all reserves for reducing metal consumption and assign specific tasks to the ministries and departments. Their fulfillment in the next 15 years will save at least 35 million tons of metal.

These, of course, are tasks for the future. But we must think about them now. The ways to solve them have been clearly defined in the draft Basic Directions: Intensify economizing practices. Persistently achieve efficient and economical use of all types of resources, reduce their losses and rapidly switch to resource-saving and waste-free processes."

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FURTHER DEVELOPMENT OF POWDER METALLURGY IN AZERBAIJAN URGED

Baku BAKINSKIY RABOCHIY in Russian 21 Dec 85 p 2

[Article by G. Akhadov and F. Mamedov, engineers: "All Prerequisites Exist for Production of Ferrous Metal Powders"; passages in slantlines printed in boldface]

[Text] BAKINSKIY RABOCHIY has published over several years materials on the prerequisites for development of powder metallurgy in the republic. Now we can talk quite specifically about the quantity, quality, and assortment of metal powders we are producing and about the growth of productive capacity to process them. Admittedly, all this relates to nonferrous metal powders. Meanshile, the draft of the "Basic Directions of the Economic and Social Development of the USSR for 1986-1990 and for the Period up to the year 2000" called for more than doubling the output of iron-based powders.

In recent years, existing methods of producing iron powders have been improved, and new, highly productive and economical methods have appeared. It should be noted that, as early as the 70s, research done at the Azerbaijan Mining-Concentrating Combine and several republic and national scientific institutions demonstrated the feasibility of obtaining and significantly improving the quality, as well as stablizing the chemical composition, of iron powders when special concentration methods are used for this purpose. These methods make it possible to process not only Dashkesan iron-ore concentrate, but also mill scale from the Azerbaijan Pipe Rolling Plant imeni V. I. Lenin.

Today methods of converting waste chips from high-speed, stainless, and bearing steels into powders have already been developed and are being successfully used in the country. Here in the republic, chips are still being remelted, as is other metal waste, although melt-processing of chip wastes is characterized by far lower technical and economic indicators than for the remelting of lump scrap, for example. There are also high melt loss and high transportation costs, even in briquette form. Chips have a developed surface. Therefore metal losses from corrosion during transportation and storage are high.

In a word, there is absolutely no doubt that it is much more advantageous to process chip wastes by powder metallurgy methods. When chips are used, the raw material base for powder metallurgy is expanded almost infinitely in terms of both volume and variety.

The line to process chips into powder consists of assemblies operating in a continuous mode. This line may be set up at any enterprise which has high chip wastes from a single grade of steel. For example, such a line could be set up in the Baku Bearing Plant, where more than 1,500 tons of chips are produced annually. A grinding slurry recovery section, with subsequent manufacture of sintered parts from the powders obtained to complete the plant's basic output, could also be created there. It is easy to calculate the savings in rolled product and the increase in the plant's other technical and economic indicators there will be due to the introduction of this process.

The republic is now identifying an additional list of machine-building parts in virtually all industries which it is feasible to produce from powders. The effectiveness of this effort will determine the rate at which powder metallurgy will develop in Azerbaijan.

Here we must also note that organization of the production of iron powder in the republic and its alloying with bronze, brass, and heat-resistant compound powders that we produce will create the prerequisite for manufacturing a completely new class of sintered structural, took, and other purpose special materials for the most diverse industries. For example, research done by VNIIPTneftemash (All-Union Scientific Research and Planning - Technological Institute for Petroleum Machine-Building), together with the Plant imeni Dzerzhinskiy, and the OKBneftemash (Special Design Bureau for Petroleum Machine-Building) on creating (sozdaniye) a series of critical parts for oil-well pumps from powder structural materials and on their long-term testing under the conditions of the Kirovneft and imeni 26 bakinskikh komissarov oil and gas extraction administrations has made it possible to increase time between well repairs by a factor of 2-2.5 and to recommend creation of a powder metallurgy section at that plant.

Another example. Comparison tests at the Baku Chemical-Pharmaceutical Plant on dies to extrude aluminum medical tubes, made of traditional die steel and of chrome and nickel carbide powders at VNIIPTneftemash, have shown a five- to sixfold increase in powder die strength.

Tests have also been conducted on a number of powder parts for oil switches and other items of the Baku High-Voltage Equipment Plan. The list of sintered parts at the air conditioner plant has been increased as a result of successful tests. This has provided a basis for developing a plan to expand the metal-ceramic section at the BZBK with an expected savings of 1.5 million rubles.

The list of such parts for the republic could go on. It is sufficient to say that, by the 12th Five-Year Plan, the scope of the use and production of sintered and sprayed parts should reach thousands of tons.

Problems of designing and manufacturing equipment for powder metallurgy and for spraying powders are being studied by the Azerelektroterm Production Association and the Transcaucasian Branch of the Central Experimental-Design and Planning-Technological Bureau of the All-Union Scientific-Production Association for Parts Restoration of the USSR State Committee for the Agro-Industrial Complex (Gosagroprom SSSR) in Baku (VNPO Remdetal). Given orders, Azerelektroterm can manufacture about seven types of electrothermal equipment for producing metal powders, sintering, and the thermo-chemical and heat treatment of metal powder parts. The VNPO Remdetal system is now series-producing more than 15 items of equipment for the restoration and hardening of the work parts of various machines and for the anti-corrosion protection of pipe and livestock farm metal structures by gas-flame powder spraying and electric-arc metallization on the basis of catalog-orders for acquisition by interested organizations.

The time has come for the republic to create a scientific-production association for powder metallurgy which can perform these tasks. It seems advisable to us to supplement the draft "Basic Directions" Section 12, "Distribution of Productive Forces and Development of the Union Republics' Economy," as follows: /"In the Azerbaijan SSR...to provide for the accelerated development of the electronic and radio engineering industries and instrument-making, particularly with extensive use of progressive methods of powder metallurgy..."/ and so on.

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NEW METAL-RELATED DISCOVERIES REGISTERED

Moscow IZVESTIYA in Russian 27 Dec 85 p 3

[Article by I. Novodvorskiy: "New Properties of Metals"; slantlines printed in boldface]

[Text] /On 26 December 1985, the USSR State Committee for Inventions and Discoveries registered two new discoveries./

The authors of the first--the Moscow State University scientists V. Gryaznov, corresponding member of the USSR Academy of Scientists, V. Shimulis, doctor of chemical sciences, and V. Yagodovskiy--studied the special state of metals at high temperatures, call "two-dimensional vapor." It has been found that metals used as catalysts in chemical reactions become more active in this condition.

The new process for activating catalysts is protected by author's certificates and is patented in the U.S.A., Great Britain, and France. In our country it will be used in vitamin production.

The second discovery was made at the Dnepropetrovsk Metallurgical Institute by V. Shapovalov, doctor of technical sciences, and V. Karpov, candidate of technical sciences. It also pertains to the field of physical metallurgy.

It has been found that hydrogen can be dissolved in a metal's crystal lattice. Then the crystals lose their external shape and flow like viscous fluids. Metal flow can be controlled by changing the pressure of the hydrogen and creating certain temperature drops. This effect is the basis for many new processes protected by 15 author's certificates.

It is hypothesized that this phenomenon occurs also in the Earth's surface layers. Indirect evidence of this is the release of a large amount of hydrogen when volcanos erupt and in seismically active regions.

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UDC 669.15'24:548.76/.73.295

MECHANISM OF LOW-TEMPERATURE SHAPE RECOVERY IN Fe-Ni ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 4, Oct 85 (manuscript received 17 Apr 84, in final version 7 Dec 84) pp 764-769

[Article by Yu. N. Koval', A. P. Kozlov and T. Ye. Monastyrskiy Metal Physics Institute, UkSSR Academy of Sciences]

[Abstract] The mechanism of shape recovery in Fe-Ni alloys below the A_{c1} austenite transformation temperature and particularly within the -100-(-196)°C temperature range, in association with the shape memory effect, is examined on the basis of experimental data and a theoretical model. Selected as representative alloys of this group had been those with a 31.2-34.2% Ni content. They were smelted in an induction furnace in an argon atmosphere. The ingots were rolled into bars of 6x12 mm^2 cross-section for homogenization by annealing at 1100°C for 20 h. The bars were then cut into 30 mm long strips of 2.0x0.4 mm^2 cross-section for water quenching from 1100°C and subsequent electrolytic polishing. These specimens were mechanically tested in flexure while their electrical resistance was measured at temperatures from -100°C to -196°C, after the shape memory effect and the critical martensite transformation temperatures had been determined in a special apparatus. The martensite structure was examined under an optical microscope. The temperature dependence of the maximum deflection in a 3-point test under various loading conditions and teh relative change of electrical resistance at -196°C after heating indicate a forward martensite transformation which, having been completed by quenching in liquid nitrogen with simultaneous load application, begins to reoccur at -150°C upon heating with or without load. Calculations are based on a model of martensite crystals which includes dependence of their critical nucleation radius and of their growth rate on the strength characteristics of the matrix and on the chemical motive force. Hardening of the matrix upon breakup of austenite grains and autocatalytic martensite formation, according to the Hall-Petch relation, can be accompanied by dynamic accomodation processes such as relaxation of elastic energy, relaxation of phase transition, and slippage. An analysis of the data indicates that under a load not exceeding the $\sigma_{0.2}$ yield strength at liquid-nitrogen temperature will cause plastic deformation upon heating, with the possibility of stress relaxation during

the forward $\gamma \rightarrow \alpha$ transition through martensite buildup during both cooling and heating. One way of improving the shape recovery in these alloys is, accordingly, to produce conditions inhibiting relaxation processes. References 9: 5 Russian, 4 Western (1 in Russian translation).

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INTERFRACTIONAL NONHOMOGENEITY OF Cr, Mn, Si FERROALLOYS

Moscow STAL' in Russian No 11, Nov 85 pp 31-35

[Article by O. S. Gorelkin, V. D. Povolotskiy, V. N. Chuvatin, A. A. Mel'nichenko and T. A. Komissarova, Scientific Research Institute of Metallurgy and Ukrainian Scientific Research Institute of Special Steels]

[Abstract] A study of everal commercial ferroalloys and silicoalloys was made for a determination of their proneness to segregation of size fractions and resulting dehomogenization. Large ingot pieces weighing up to 300 kg were comminuted and the material separated into 6-8 size fractions ranging from dust (smaller than 0.05 mm) through powder (0.4-1.0 mm and 1.0-2.5 mm) to lumps (up to 0.70 mm). The phase composition of the fractions was identified on the basis of local testing with a "Kameka" MS-45 electronic probe, aided by optical metallography, x-ray structural examination, and microhardness measurements. Interfractional nonhomogeneity was thus established in specimens of ferrosilicons Fs75/65/45, high-carbon ferrochromium FKh800A (70.8-73.0% Cr, 7.3-7.9% C) containing $(Cr,Fe)_7C_3$ and $(Cr,Fe)_{23}C_6$ carbides, ferrosilicochromium FSKh20 (50.1% Cr, 20.3% Si, 3.4% C) containing $(Cr,Fe)_5(Si,C)_3$ carbosilicide, ferromanganeses FMn70/75 (71.8-78.4% Mn, 6.2-6.6% C, 0.9-1.8% Si) containing 70-75% $(Mn,Fe)_7C_3$ carbide and 7? 7% $(Mn,Fe)_{23}C_6$ carbide, and silicomanganeses SMn14P/17P containing 6?% $(Mn,Fe)_5Si_3$ silicide. The interfractional nonhomogeneity was found to be sufficiently appreciable to require special techniques for fr.ctionized production as well as safety measures. V. P. Bratchenko and \. F. Andrianov participated in the study. References 9: 6 Russian, 1 Czechos ovak, 2 Western.

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PROCESSES OCCURRING DURING REDUCTION AND ALLOY FORMATION IN MoO_3-WO_3-H_2 SYSTEM 1. DISPERSION OF REACTION PRODUCTS IN REDUCTION OF MIXED OXIDES OF MOLYBDENUM AND TUNGSTEN

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 24 Dec 84) pp 1-5

[Article by M. P. Savyak, I. V. Uvarova and I. I. Karpikov, Institute of Material Science Problems, UkSSR Academy of Sciences]

[Abstract] Numerous studies of reduction in binary and more complex oxides have shown interaction of solid phase components with hydrogen during chemical reactions. The present article reports on mixed oxides of $Mo_xW_{x-1}O_3$ obtained by annealing a mixture of molybdenum trioxide and tungsten at 700-800°C for 24 hours. Subsequent reduction temperatures ranged from 250-300°C to 650°C; these temperature along with those of subsequent carbidization and a key role in producing complex carbides. Details of crystalline structure are summarized. Study of kinetics indicated that as molybdenum content increased the level of reduction at 370°C also increased. The intermediate products of tungsten reduction were found to have a stabilizing effect on retaining a high degree of dispersion of the products of Mo reduction from the trioxide at temperatures of 500-550°C. With a Mo content of 60%, the molybdenum crystals retained their needle-like forms. Reduction products of this mixture had the greatest specific surface at low reaction rates. References 9: 7 Russian, 2 Western.

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EFFECT OF PARTICLE DIMENSIONS ON QUANTITY OF RESIDUAL AUSTENITE IN SPRAYED POWDERS OF HIGH-SPEED STEELS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 18 May 84) pp 6-8

[Article by A. N. Popandopulo and V. I. Kalinina, Leningrad Polytechnical Institute]

[Abstract] Contradictory data have been encountered on the amount of residual austenite in large and small particles of sprayed powders of high-speed steels. The present article reports on a study of sprayed coatings of various steels. X-ray photography and difractograms showed particles of 50-100 mcm had reduced erosion and greatly increased martensite content. Further measurements were made of the ferrite and martensite lines of the spectrum. Results showed that changes in the austenite

structural matrix were directly dependent on carbon content. More precise measurements were made of the carbon content in the martensite and austenite of M6F3C2-MP steel; the quantities of the two were found to be essentially in the same in large particles. Silicon increased the quantity of the δ-phase and promoted elimination of alloying elements from austenite and of carbides from martensite. References 12: all Russian.

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UDC 621.762.274

ELECTROPRECIPITATION OF HIGH-DISPERSION COBALT POWDERS FROM ELECTROLYTES OF VARIOUS ANION COMPOSITION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 15 Jan 85) pp 9-12

[Article by Ye. P. Zhelibo, V. N. Andrushchenko and T. N. Amelichkina, Colloidal Chemistry and Hydrochemistry Institute, UkSSR Academy of Sciences]

[Abstract] Electrical precipitation of high-dispersion cobalt powders has been studied using chloride solutions and various other suspensions. The present article reports on a study to establish the possibility of the electrical precipitation of high-dispersion cobalt powders from solutions of various anion composition in order to choose the type of electrolyte to be used in producing these powders in a two-layer pool from industrial solutions. Electrolysis was performed in a two-layer pool with a 45 mm diameter revolving nickel disc cathode having a 0.02 dm^2 working surface. Cobalt chlorides and sulfates were used as electrolytes. Increasing electrolyte temperature permits reduction of cobalt overvoltage. Two processes can also occur with increased temperature. i.e., desorption of organic substances from the electrode surface and increased chemical reaction of higher fatty acid molecules with the cathode surface. The hydrogen index of the electrolyte was of particular importance. Since the hydrometallurgical procedures involved in processing the cobalt-containing material included reduction of cobalt hydroxide by sulphur dioxide in the presence of H_2SO_4 the solution derived from electrolysis contained large amounts of sulfate ions. Therefore a Cl^- : SO_4^{2-} ratio of 1 : 5 was assumed when studying the influence of electrolyte concentration and current density on the process of precipitating high-dispersion cobalt powders Electroprecipitation of such powders from sulfate and sulfate-chloride electrolytes, in contrast to chlorides, requires temperatures of 45-50°C and reduced current density of approximately 50 A/dm^2. References 10: all Russian.

12131/9835
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UDC 621.9.048.4:621.762.277

PROCESSING TUNGSTEN SCRAP INTO POWDERS BY ELECTROEROSIVE DISPERSION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 27 Mar 85) pp 17-22

[Article by L. P. Fominskiy, A. S. Myuller, M. V. Levchuk and V. P. Tarabrina, Tulachermet Scientific Production Association]

[Abstract] Use of tungsten and tungsten alloy scrap is of great importance since the metal is scarce. The present article reports on a study of electroerosive dispersion processes in water that makes it possible to use shavings and other fine metal scraps; the process is ecologically preferable to chemical methods isnce there is no sewage or harmful emissions. After processing and drying, the resulting metal powder was studied with a metallographic microscope, which determined that most particles were spherical, with some 20% chip-like. The powder obtained satisfied established standards, with no more than 20% of the particles exceeding 6 μm, but size distribution was somewhat erratic. Further processing included centrifuge treatment of the suspension and heating to 90°C to precipitate ultra-dispersed particles which coagulated and then were dried. Analysis showed that the material was tungsten oxide with 0.74% oxygen content, along with purely metallic tungsten containing up to 30% beta-modified metal. Considerable economy is attributed to the electroerosive dispersion process tested. References 10: all Russian.

12131/9835
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UDC 01.001.18:621.762:666.3/7:661.8

CURRENT PROCESSES AND MATERIALS OF POWDER METALLURGY

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85
(manuscript received 17 Apr 85) pp 69-78

[Article by Ye. L. Shvedkov and I. I. Kovenskiy, Institute of Material Science Problems, UkSSR Academy of Sciences]

[Abstract] The article surveys Soviet and foreign progress in the development and use of powder metallurgy. Widespread reports on production of ribbon metal forms from amorphous fine-crystalline and amorphous powders began to appear in the 1970s. Various Japanese and American firms originally led the way in producing previously impossible metals such as $LiNbO_3$, $KTaO_3$, and $Li_2Mo_2O_7$. Spray technology with WC-Co in CCl_4 and complex oxides of La, Sr and Mn were produced by Japanese and German firms. Extrusion by the "Conform" process and compaction during sintering by the "PAS" process,

and a process for mixing crystalline powders with amorphous powder developed at Cal Tech, are described. Composite and ceramic materials have recently received increasing attention; they include magnetic Nd-Fe-B materials with wide applications in low-cost magnetic products without use of scarce cobalt. The component niodim, however, is itself a scarce mineral. Silicon nitride has found wide application in instrument ceramics, while later advances have produced so-called sialons that have great technical promise. Composite materials that overcome the problems of ceramics such as brittleness are also being developed. Similarly, hybrid carbon-carbide compounds are surpassing the technical properties of carbon-carbon materials. A 90% Al_2O_3 combination with 10% AlN sintered at 2073 K under 40 MPa pressure has yielded a material with high durability that is not effected by operating temperatures. An example of heat resistant material is Quilite, used in the US space shuttles Challenger and Discovery. References 47: 6 Russian, 41 Western (2 in Russian translation).

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CSO: 1842/101

UDC 621.74:658.2:621-183.2:621.979.06

INCREASING TECHNOLOGICAL LEVEL OF METALLURGICAL PRODUCTION OF CRANK-PRESSING MECHANISM (CPM) PARTS

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 22-23

[Article by V. T. Bogdyl']

[Abstract] Increased production of heavy presses and their improved design and reliability has led the metallurgical shops of the Voronezh Production Association for Heavy Metal Presses to seek ways for instituting comprehensive mechanization of technical processes and for improving other technology in order to improve the operational properties of cast parts. Quality improvements in parts made of iron cast in sand molds have come from precision filtration of the metal in gating systems, thus eliminating slag, non-metallic impurities and large gas bubbles from the final metal. Centrifugal casting is used to produce balance cylinders, which cannot have internal casting defects. For non-ferrous metal castings new technology has been introduced that utilizes electric arc furnaces with 1.2 ton drum capacity, which permit melting and production of up to 2.4 tons in a single operation. For short-run or individual production of bronze ingots casting in a chill mold and centrifugal casting have also enjoyed advances. More than half of the total output of bronze ingots with diameters of 80-1,000 mm are produced by centrifugal casting. In the forging shop Soviet presses with greater power have replaced the imported presses formerly used. Production of coil springs at the plant has also been modernized. Quality control has been enhanced by use of ultrasound and magnetic powder defectoscopy.

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UDC 621.762.04.001.5

EFFECT OF IMPULSE LOAD ON PROPERTIES AND STRUCTURE OF [METAL] POWDERS

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 36-37

[Article by V. K. Shafravskiy]

[Abstract] High quality extrusion of blanks from powders with predetermined properties entails use of the principle of the self-synchronization of dynamic systems and control of structure formation. The extrusion of products from powders under impulse loads is based on one of the postulates of the theory of self-synchronization. The present article reports on experimental testing of the impulse extrusion of powders, determination of approximate parameters and procedures, and study of the physicomechanical characteristics and structure of extruded blanks. The experiments showed that use of impulse load extrusion makes it possible to reduce technical extrusion force by a factor of 3.5 when iron powder mixtures are being used. Pressure was reduced from 700 to 200 MPa, while specimen density was increased from 4.99 g/cm^3 to 5.48 g/cm^3. Further processing brought even more quality improvements and resulted in properties that surpassed both common cast and alloyed steel specimens. Porosity was 30-50% less than for specimens produced under static loads. The latter method required 1400 MPa to produce equivalent physicomechanical properties. References 2: both Russian.

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CSO: 1842/109

UDC 669.187.2:621.74.02

CENTRIFUGAL ELECTROSLAG CASTING OF BILLETS FROM COPPER SCRAP

Kiev PROBLEMY SPETSIAL'NOY ELEKTROMETALLURGII in Russian No 4, Oct-Nov-Dec 85 (manuscript received 18 Mar 85) pp 23-25

[Article by A. I. Borodin, B. I. Medovar and B. B. Fedorovskiy, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] Many copper and copper alloy machine parts are made from castings which are subsequently turned into final shape. The present article reports on a study of the possibility of collecting the scrap from such processing and re-using it to make billets for additional parts by means of a centrifugal electroslag casting process. The scrap was remelted using fluxes of the CaF_2-CaO-Al_2O_3-SiO_2 system, which have a melting temperature close to that of copper and a large crystallization range, thus producing billets with a high-quality surface. Crystallization was done without direct liquid metal contact with the mold surfaces. Results

indicated that the process makes it possible to reduce the content of lead, tin and sulfur in the billets, but Fe and Zn impurities can increase due to contamination of the scrap. The level of impurities did not exceed state quality standard (GOST) parameters, and no significant macrostructural defects were found. The proposed technology is lower in cost than induction smelting, and the capital investments and space requirements are minimal. References 2: both Russian.

12131/9835
CSO: 1842/105

UDC 621.771.014

OPTIMIZATION OF TEMPERATURE-SPEED CYCLE FOR HOT ROLLING IN CONTINUOUS-DUTY WIDE-STRIP MILL

Moscow STAL' in Russian No 11, Nov 85 pp 40-43

[Article by S. A. Bratus', Institute of Ferrous Metallurgy]

[Abstract] Optimization of the temperature-speed cycle in continuous hot rolling is considered, specifically for wide-strip mills, on the basis of metallographic and microstructural examination as well as deformation and cooling characteristics. The key criterion is the final rolling temperature, necessarily not lower than the Ar_3 temperature, the reeling temperature to be 22-38% lower. Several mathematical models have been constructed for the final rolling temperature as a linear function of four other technological parameters in the form of regression equations, those parameters being initial rolling temperature, rolling speed, initial and final strip thicknesses, so that the rolling speed necessary for ensuring the appropriate final rolling temperature can be calculated for any specific final strip thickness, grade of steel, and type of model of rolling mill. The coefficients in these equations are determined empirically and statistically. Such calculations have been made for 1.5-3.5 mm thick strip of 08kP, 08Yu, 08Fkp steel to be produced in any of eight rolling mills in various metallurgical plants in the USSR. Engineer E. N. Barysheva of the Magnitogorsk Metallurgical Combine participated in the study leading to development of this optimization method. References 4: all Russian.

2415/9835
CSO: 1842/95

UDC 621.762.5:621.771.23

WELDING OF STRIPS IN ENDLESS-ROLLING MILL

Moscow STAL' in Russian No 11, Nov 85 pp 44-45

[Article by S. G. Molchadskiy, V. G. Mokeichev and O. N. Soskovets, All-Union Scientific Research and Planning-Design Institute of Metallurgical Machine Building and Karaganda Metallurgical Combine]

[Abstract] The model-1400 six-stand endless rolling mill built at the Ural Heavy Machine Building Plant and installed at the Karaganda Metallurgical Combine includes a KSO-80.01 (L1700M) welding set which has been developed at the All-Union Scientific Research and Planning-Design Institute of Metallurgical Machine Building and built at the Pskov Heavy Electric-Welding Equipment Plant. This set includes two support columns joined through a hinge. The stationary one carries two welding transformers, a single-phase thyristor-type chopper, and a supply transformer with voltage regulation on the primary side and 10 kV on the secondary side. It also carries a centering device and trimming shears. The movable one carried clamps and electrodes, its displacement being program-controlled. There is in addition a separate floating deburrer with a hydraulically driven lever mechanism and a chip trap. Auxiliaries include a storage battery, a pump, and a mechanism for replacement of consumed electrodes. A major consideration in development and design of this welding set was elimination of seam breakage during rolling down to 90% reduction. References 12: all Russian.

2415/9835
CSO: 1842/95

UDC 669-419.4.001.4

COMPARATIVE EVALUATION OF ROLLING AND SETTING PROCESSES IN PRODUCTION OF BIMETALS

Moscow STAL' in Russian No 11, Nov 85 pp 50-51

[Article by N. P. Gromov, N. D. Lukashkin and T. I. Bashkirova, Moscow Evening Metallurgical Institute]

[Abstract] Rolling has been found to produce better bimetal stacks than setting when the two metals are not equally stiff. This is explained by the interrelation between physical factors and geometrical factors which determine both the process performance and the product quality. The principal physical factors are interlayer friction, roughness of interlayer surfaces, and distribution of laminar strains. The principal geometrical factors are relative thicknesses of layers and stacking symmetry or asymmetry. A typical pair of metals with very different deformation and other characteristics are the hard Cr18Ni10Ti steel and the soft AD1

aluminum. While vacuum-tight symmetric (soft-hard-soft) and asymmetric (hard-soft) stacks with string bonding of thick soft layers to thin strong layers can be produced by rolling to 35-40% reduction only, such stacks cannot be produced by setting even with a 50% height reduction. A quantitative analysis of data indicates that adequate interaction between layers of these two different metals is achieved by their nonuniform deformation within the contact area, while the stack geometry is best controlled with uniform laminar deformation and minimum surface roughness. References 2: both Russian.

2415/9835
CSO: 1842/95

UDC 621.775.26:621.789

DEVELOPMENT AND ADOPTION OF TECHNOLOGY FOR QUENCHING BALL-MILL BALLS FROM HOT-ROLLED TEMPERATURE

Moscow STAL' in Russian No 11, Nov 85 pp 71-72

[Article by A. N. Klimenko, V. L. Kostrykin, A. P. Sichevoy, Yu. P. Gladilin, V. A. Grin and A. Ya. Zelikovich, Ukrainian Scientific Research Institute of Metallurgy; Metallurgical Combine imeni F. E. Dzerzhinskiy; Dnepropetrovsk Metallurgical Institute; Ukrainian State Institute for the Planning of Metallurgical Plants]

[Abstract] Balls for grinding are made of medium-carbon or high-carbon steel and produced by transverse hot rolling with subsequent quenching. Balls 40-60 mm in diameter must have a Brinell hardness of at least 4000-4500 N/mm^2 (class N) or 4510-5500 N/mm^2 (class P). Conventional heat treatment of such balls involves quenching in running water through which motionless balls in baskets are passed by a conveyor while they are still at a temperature higher than optimum, without adjustments for different ball diameters and different grades of steel. For production of high-quality balls, a new quenching technology has been developed which not only permits wide-range process control but also includes rotation of balls in the process, thus ensuring their uniform hardness. Balls are first air cooled from the hot-rolled temperature for 40-100 s and only then quenched in a drum revolving at a circumferential velocity of 0.1-1 m/s with water running at a velocity of 10-35 m/s at a 5-60° angle to the direction in which the balls are moving. Conveyor speed and drum speed are controlled within ranges compatible with high productivity of the operation. Two drums with conveyor screws have been designed, built, and installed at the Metallurgical Combine imeni F. E. Dzerzhinskiy, for balls 40, 50, 60 mm in diameter made of Sh1 or Sh2 steel. Depending on the diameter, the balls are precooled in air for 40, 50 or 65 s and then quenched from 830-880°C, 830-900°C, or 900-950°C respectively. The quenching process is controlled to prevent cracking of balls, to which 60 mm balls made of Sh2 steel are most prone, so that their surface hardness must not exceed 6000 N/mm^2 on the Brinell

scale. On the basis of a comparative experimental evaluation, the performance indicators of the new technology are much better than those of the old one. This has been confirmed by the superior performance of balls produced by the new technology for the Northern Mining and Ore D essing Combine.

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UDC 621.762

AGEING OF POWDER MARAGING STEEL N14K7M5T2

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 7 Feb 85) pp 86-89

[Article by V. N. Antsiferov, L. M. Grevnov and N. N. Maslennikov, Perm Polytechnical Institute

[Abstract] A study was made by electron microscopy of the process of the ageing of sintered maraging N14K7M5T2 steel at temperatures of 460-590°C and with isothermal holding for 40 minutes to 10 hours. The aim was to determine the type of phases emitted, their dimensions and form and growth kinetics in relation to the ageing regimen. Analysis of extraction replicas produced from the quenched specimens indicated the presence of round titanium oxide particles and laminar Ti_2Co intermetallides, formed during sintering, which increased the steel's brittleness and promoted the initiation of local failure sites. A strengthening Ni_3Ti phase, needle-like in form, was isolated as the steel aged. Its particles grew evenly thorughout the entire volume at a constant rate. Isolation of the intermetallides was completed within 1 hr of ageing at 590°C. Particle coagulation then began. References 4: 3 Russian, 1 Western.

12131/9835
CSO: 1842/101

UDC: 621.771.01

STUDY OF QUALITY OF PIPE PRODUCED BY PRESSING MULTI-LAYER BLANKS AND HELICAL ROLLING

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 23 Apr 84) pp 57-60

[Article by A. P. Kolikov, M. A. Bondarev, V. A. Pravikov, A. A. Golovachuk, A. A. Snegirev and L. V. Mayorova, Moscow Steel and Alloys Institute]

[Abstract] Analysis of the accuracy of the dimensions of pressed pipe blanks showed that as the D/S (D=external diameter, S=wall thickness) ratio,

temperature and drawing increase, the transverse and longitudinal wall thickness differences also increase. When thick-wall pipe is pressed from molybdenum powder, transverse wall thickness difference is 4-5% for D/S not over 4, increasing to 10% when D/S equals 4.5. It has also been experimentally established that the relative length of the leading and trailing ends of a product in which the wall thickness differs from the mean value by over 10% depends greatly on the drawing factor and initial D/S ratio. The pressing of multilayer pipe blanks with intermediate plastic layers, subsequent helical rolling without a mandrel and helical rolling on a short mandrel allows high quality pipe 10-50 mm in diameter and 0.3-1.5 m in length to be produced of refractory metals and alloys. References 3: all Russian.

6508/9835
CSO: 1842/107

UDC: 669--138:621.984.5

CALCULATING THE PROCESS OF EXTRUSION OF A POWDER BLANK THROUGH A CONICAL DIE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 7 Dec 84) pp 81-84

[Article by V. A. Osadchiy, V. T. Zhadan, N. L. Gavrilov-Kryamichev, V. A. Gorovoy, N. I. Dolgiy, and Yu. A. Skornyakov, Ukrainian Scientific Research Institute of Special Steels]

[Abstract] Previous works have used the method of finite elements to describe processes of deformation of porous powdered blanks. The present work utilizes this method to study and calculate the process of extrusion of capsules full of powdered high-speed steel through a conical die. An elastic-plastic continuous medium with the capability of irreversible volumetric deformation was used as the working model. It was assumed that hardening of the porous body occurred only due to an increase in its density, with no hardening of the base metal. The properties of the base metal were assumed to be isotropic and the process isothermal. The mathematical model derived is based on the concept of the flow surface and the associated flow rule. Numerical experiments are performed to study the process of hot extrusion of capsules with high-speed steel powder. The influence of the thickness of the leading cover of the capsule on distribution of deformations and porosity is demonstrated. References 9: 7 Russian, 2 Western.

6508/9835
CSO: 1842/106

UDC: 621.78.014

PRODUCTION OF HEAT RESISTANT LAYERS UPON LASER HARDENING OF STEEL

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 11, Nov 85 (manuscript received 26 Nov 84) pp 112-115

[Article by S. A. Isakov, V. P. Pakhadnya and V. M. Kartoshkin, Mogilev Technological Institute]

[Abstract] A laser beam with sufficient power density causes carbon applied to the surface of steel to be converted to a chemically active plasma, while melting the surface layer of the steel and causing turbulent mixing of the carbon in the melted steel bath. Heating and cooling rates of 10^3-10^4°C/s can be achieved. This supercritical cooling rate causes hardening of the melted zone to as high as 14,000 MPa. Case hardening with heating by a laser beam can yield layers with carbon concentration corresponding to hypo-eutectic, eutectic or hypereutectic white cast iron with good red hardness. References 4: all Russian.

6508/9835
CSO: 1842/106

UDC 621.73.016.001

DEVELOPING A TECHNICAL PREPARATION SYSTEM FOR BATCH PRODUCTION OF PARTS BY THE COLD DIE FORGING METHOD

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 26-28

[Article by A. E. Artes]

[Abstract] Cold die forging as a promising low-waste production method for small-series and series production enterprises should receive priority development in the USSR in the coming decade. However, lack of experience in batch processing in this field and of scientifically valid recommendations for the profitable operation of such shops hinders the broad introduction of the technology. The author has worked on the problem of eliminating the contradictions between the capabilities of highly-productive presses and the small sizes of the batches of parts being forged. He has developed a system for the technological preparation of the batch production of parts by cold forging methods in order to solve the many problems related to the creation in the near future of hundreds of cold die forging sections in machine-building and instrument-making enterprises with small-series and series production. This system is diagrammed and discussed. One of the most important aspects of the system is the procedure for the grouping of parts, the purpose of which is to reduce labor and other costs to the level

achieved in mass production. The batch processing of parts in a typical cold drop forging section is diagrammed and discussed. The profitable operation of such a section will depend on the calculation of optimal batches and on optimal utilization of the presses. The author has developed mathematical-economic models of press utilization which can be used under batch production conditions. References 4: all Russian.

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CSO: 1842/109

UDC 621.73.077

LOADING MACHINE BASED ON ELECTRIC LIFT TRUCK

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 11, Nov 85 pp 37-38

[Article by B. A. Chelishchev and V. A. Naumov]

[Abstract] Early loading machines based on electric lift trucks operated by storage batteries had a number of shortcomings that are eliminated by the modernized version described in the present article. The electrical cords are protected by a cord that signals when their range is reached, the storage batteries have been removed and counterweights placed in their stead for balance, and the lifting height reduced to provide a more reliable telescoping function. Furnace loading is controlled from the loading machine control panel. The design makes it possible to readily replace the electric lift truck for repairs. Technical data are given in a table.

12313/9835
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UDC 621.375.826

CASE HARDENING OF METALLURGICAL EQUIPMENT PARTS BY LASER TREATMENT

Moscow METALLURG in Russian No 12, Dec 85 p 18

[Article by T. V. Rovenskaya, T. B. Vakulina, A. I. Sharapov and N. Ye. Yakubovich, Tulachermet Scientific Production Association]

[Abstract] A laser treatment for case hardening of metallurgical equipment parts has been developed by the Tulachermet Scientific Production Association, especially for parts of equipment operating under most severe conditions of combined cyclic and static mechanical and thermal stresses. The treatment, with an LT1-2 continuous-wave 5 kW CO_2-laser facility which includes a fast-flow gas dynamic loop, was designed for and proved out on critical parts

such as ladle sleeves and bucket pins made of St 3 and St 45 carbon steels respectively. The working surface of such parts is, for this treatment, covered with a layer of graphite for better absorption of laser radiation at the 10.6 μm wavelength. A martensite surface layer of 6600-6800 MPa microhardness is produced on both steels by optimum laser treatment at the 2 kW power level, which approximately doubles the life of such parts.

2415/9835
CSO: 1842/103

UDC 621.785.52

GAS CARBURIZATION IN ACTIVE FURNACE GAS WITHOUT ADDING EXCESS METHANE TO THE FURNACE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 2-7

[Article by V. V. Chekanskiy, Minsk Design-Technological Experimental Institute]

[Abstract] A method is suggested for preparing controlled atmospheres allowing high values of carbon potential to be achieved in a furnace without the addition of excess methane by preliminary deep drying of the gas before it is fed into the furnace. Water vapor is thus removed from the gas, the composition of which is obtained in a generator in accordance with the equilibrium equation of the water gas reaction. The result of the processes that occur is that the content of carbon monoxide increases, that of carbon dioxide decreases, and the carbon potential of the gas in the furnace increases in comparison to that obtained in the generator. Laboratory investigation and industrial testing of the method are described. Activation of the atmosphere of endogas with a dew point of +12°C provides a carbon potential in the furnace atmosphere of about 1.25% C without the addition of natural gas. The use of this activated endogas can prevent the liberation of carbon black in the furnace. By activating the endogas, one can raise the dew point of the endogas in the generators serving the case hardening furnaces from 0 to 12°C. The longevity of the catalyst and the operating time between repairs for the generator as a whole are thereby considerably increased. A savings of natural gas is also achieved. References 9: 8 Russian, 1 Western.

6508/9835
CSO: 1842/100

UDC 669.046.562

KINETICS OF CARBURIZATION IN NITROGEN-HYDROGEN MEDIUM WITH ADDITION OF PURE METHANE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 7-11

[Article by B. M. Estrin, O. S. Minushkin and M. A. Shkol'nikov, Tsentroenergochermet]

[Abstract] A nitrogen-hydrogen atmosphere with the addition of various gaseous hydrocarbons is most promising for the replacement of standard carburization gas. Hydrocarbons can be placed in the following sequence in terms of increasing carburizing activity: CH_4, C_2H_6, C_3H_8, C_4H_{10}. The use of higher hydrocarbons requires precise dosage measurement, due to the high rate of formation of pyrocarbon on the surface of metal as a result of thermal dissociation of the higher hydrocarbons. A pilot-scale muffle furnace installation was made to study the process of carburization in a circulating N_2-H_2-CH_4-CH_2-H_2O atmosphere. Full kinetic analysis of the process of saturation of steel with carbon was undertaken. The activation energy of the process depends on the carbon content in the steel and can be determined from the equation $Q=(55000+e^{11C})\cdot 4.18$, kJ/mol, where C is the steel carbon content in %. The mass transfer coefficient decreases with increasing carbon content in the steel. The specific flux of carbon into the metal depends largely on carburization temperature, methane content in the gas mixture and carbon content in the steel. References 13: 9 Russian, 4 Western.

6508/9835
CSO: 1842/100

UDC 669-138.15:621.785

SPECIFICS OF THERMAL CYCLING TREATMENT OF TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 85 pp 41-45

[Article by V. S. Lyasotskaya, N. Yu. Ravdonikas and I. A. Lebedev, Moscow Aviation Technical Institute]

[Abstract] The authors have obtained data indicating that the reduction in grain size of cast VT5 alloy during thermal cycling treatment can be facilitated by preliminary hydrogenation. The effect of thermal cycling in this case is related to the $\alpha \rightarrow \gamma$ conversion. The heating rate influences the conversion temperature and grain size at the temperature to which the alloy is heated. The cooling rate determines the mechanism of conversion

(diffusion, diffusionless, intermediate), its completeness, the degree of alloying of the phases and structural changes. Holding at the high temperature end of the cycle should be minimal, though sufficient to convert the alloy to the necessary phase state. Increasing holding time at this stage causes relaxation of microstresses and rapid grain growth. Thermal cycling of titanium alloys can increase both specific properties of parts and semi-finished goods and the entire range of mechanical properties. Various types of heating can be used, including furnace, salt and metal melts, induction and electron beam heating. An entire part or only a portion of a part may be thermally cycled. References 24: all Russian.

6508/9835
CSO: 1842/100

UDC 621.774.21

IMPROVEMENT OF HIGH-FREQUENCY WELDING TECHNOLOGY FOR PRODUCTION OF STRAIGHT-SEAM TUBES

Moscow STAL' in Russian No 11, Nov 85 pp 54-55

[Article by I. T. Totskiy, A. N. Korotkiy, G. V. Aksyuchits, G. K. Zavyavlova and N. A. Bezukladnikova, Northern Tube Plant]

[Abstract] At the Northern Tube Plant tubes of 16GS steel, 102 mm in diameter with 2.2 mm wallthickness, are welded along a straight seam with the TESA electric high-frequency (440 kHz) tube welding set. For the purpose of improving this tube production technology, a study was made to determine the dependence of the joint strength in terms of allowable diametral tube expansion on the chemical composition of the steel and on the welding speed as well as other technological parameters. After welding, tubes were tempered in a sectional feed-through gas furnace at 670-740°C for 1.25 min and then air-cooled. With a diametral expansion of at least 5% allowed during welding at the rate of 40 m/min, the joint strength was found to depend on the carbon equivalent of the steel as well as on the combined sulfur and phosphorus content. It was found to also depend on the shift of the joint edges and on the subsequent stability of that shift. Only 3.8-9.7% diametral expansion was tolerable at the welding rate of 55 m/min, with the steel strip edges bent down. As much as 11.5-31.5% diametral expansion was tolerable at the welding rate of 20 m/min, with the steel strip edges bent up. On the basis of these results, tubes are now welded with the steel strip edges bent up, steel strip with edges bent down being turned around 180° prior to welding. Tubes of steel with a carbon equivalent higher than 0.40% and containing more than 0.055% sulfur+phosphorus are welded at rates up to 25 m/min. Tubes of steel with a carbon equivalent greater than 0.40% and containing 0.041-0.055% sulfur+phosphorus are welded at rates up to 30 m/min. Tubes of steel with any carbon equivalent but containing less than 0.041% sulfur+phosphorus are welded at rates up to 40 m/min. The carbon equivalent is calculated as

$C_{eq} = C + \frac{1}{6}Mn + \frac{1}{5}Cr + \frac{1}{40}Mo + \frac{1}{24}Si$. References 1: Russian.

2415/9835
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CYCLICAL STRENGTH OF THERMALLY STABLE STEELS AND THEIR WELDED JOINTS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 85
(manuscript received 25 Jan 85) pp 1-4

[Article by V. V. Gorynin, academician, V. A. Ignatov, doctor of technical sciences, B. . Timofeyev, candidate of technical sciences, and T. A. Chernayenko, engineer, Leningrad]

[Abstract] Results of tests of thermally stable steels type 15KH2MFA, 15KH2NMFA and their welded joints for cyclical strength are systematized. Primary attention is given to the influence of technological factors on the cyclical strength of the metal. The influence of various factors on the endurance of the materials studied was estimated by comparing endurance characteristics such as the limits of endurance or of durability at a fixed stress level. Fatigue testing was performed in pure flexure with rotation and a balanced loading cycle at temperatures of 20 and 350°C. Primary attention was given to such technological factors as purity of the steel and contamination of the welding wire with harmful impurities. The fatigue limit for bending with 10^7 cycles calculated from the experimental results correlates well with strength characteristics of the materials determined by one-time testing. At both temperatures, fatigue limit is about 1/2 short-term tensile strength. References 7: 6 Russian, 1 Western (in Russian translation).

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STRENGTH OF JOINTS MADE BY ARC SPOT WELDING IN STRUCTURES FOR NORTHERN USE

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 85
(manuscript received 5 Dec 84) pp 5-7

[Article by S. V. Krylov, candidate of technical sciences, A. Ye. Asnis, doctor of technical sciences, A. N. Nazarenko and A. A. Kazimirov, engineers, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian SSR Academy of Sciences; and V. M. Bubnov, engineer, Zhdanovtyazhmash Production Association]

[Abstract] A study is presented of the mechanical properties and endurance of various areas of a welded joint against brittle fracture at temperatures close to the normal usage temperatures, as well as the dynamic strength of joints made by traditional single-cycle and by two-cycle spot welding. The two-cycle method forms the joint in two stages. Selection of optimal

process parameters normalizes the weld in the heat-affected zone in the plane of contact of the welded elements. The work expended in crack propagation, the size of the critical crack opening in the weld and heat-affected zone and strength under impact loading at low temperatures all confirm greater brittle fracture resistance of joints obtained by two-cycle spot welding. The endurance limit of joints made by this method was 20-25% higher than those made by single-cycle welding and 20-30% greater than riveted joints. Operation of tank cars on the railroads of Siberia and the Far East confirms the good reliability of these joints for cold conditions. References 4: all Russian.

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LOW-CYCLE FATIGUE OF WELDED JOINTS IN CRYOGENIC EQUIPMENT

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 85
(manuscript received 11 Nov 84; in final form 6 May 85) pp 12-16

[Article by V. M. Muratov, L. N. Kopysitskaya, candidates of technical sciences, Kriogenmash Scientific Production Association, Balashikha, Moscow Oblast; E. V. Chechin, candidate of technical sciences, Institute of Strength Problems, Ukrainian SSR Academy of Sciences; and G. K. Sharshukov, candidate of technical sciences, Moscow Institute of Construction Engineering]

[Abstract] A study is made of the possibility of using low-temperature hardening of materials used in the manufacture of high-pressure vessels operating at low temperatures. Results are presented from an experimental study of the strength and low-cycle fatigue resistance of welded models of vessels made of 12KH18N10T steel at normal and low temperatures. Studies were performed under static and repeated static loading by internal pressure at 293 and 77K. A comparison of fracture pressures in vessels with and without stress concentrators at both temperatures shows that the presence of slots with a radius of 3 and 5 mm and depth of 4 mm has practically no influence on static strength at 293K, decreasing static strength by about 9% at low temperature. Sharper stress concentrators may seriously decrease load-bearing capacity, particularly at low temperatures. Decreasing the operating temperature to 77K causes an increase in the static strength of the vessels. Durability is longer at low temperatures than at room temperature. References 7: all Russian.

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INFLUENCE OF TEXTURE AND STRUCTURE ON ANISOTROPY OF PHYSICAL-MECHANICAL PROPERTIES OF WELDED JOINTS IN ALLOY OF ZIRCONIUM WITH 2.5% NIOBIUM

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 85
(manuscript received 27 Dec 84; in final form 12 May 85) pp 17-19

[Article by A. A. Bryukhanov, candidate of physical-mathematical sciences, A. B. Goncharov, A. V. Manzhikov, engineers, M. M. Nerodenko, doctor of technical sciences, and A. F. Tarasov, engineer, Odessa, Kiev]

[Abstract] A study is made of the influence of texture and structure on elastic, electrical and mechanical properties of welded joints and base metal in an alloy of zirconium plus 2.5% niobium. Experiments were performed on alloy sheets 2 mm thick as delivered and after hardening from 1200K in water. Sheets were welded with a nonconsumable electrode at 180A, 18V and 1.66cm/s at various angles to the rolling direction. The content of the active gasses in the welding atmosphere was limited to avoid the influence of impurities on texture and structure. The texture was found to inherit the texture of the initial metal as delivered. Anisotropy of Young's modulus and electrical resistance retains its nature in the heat-affected zone and weld metal, though the minimum value of Young's modulus is found in welds made at 45° to the rolling direction. Formation of a hardened martensite structure of the α' phase of the zirconium results in a sharp increase in strength, decrease in plasticity and suppression of the influence of texture on mechanical properties, although anisotropy of Young's modulus and electrical resistance are preserved at the level in the base metal. References 10: 9 Russian, 1 Western (in Russian translation).

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KINETICS OF ABSORBTION AND LIBERATION OF HYDROGEN BY 3-LAYER METAL MATERIAL OBTAINED BY HIGH TEMPERATURE SOLDERING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 85
(manuscript received 19 Jul 84) pp 23-25

[Article by G. V. Kutyrkin, L. K. Oskolkova, engineers, V. L. Mirochnik, candidate of technical sciences, All-Union Scientific Research and Planning Institute of the Technology of Petrochemical Apparatus Construction; Yu. A. Sterenbogen, doctor of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian SSR Academy of Sciences]

[Abstract] A comparative analysis is presented of the quantities of hydrogen absorbed and liberated by 20YUCH steel in single and triple-layer form under various hydrogenation conditions. The three-layer material consisted of type 20YUCH steel, a layer of copper alloy and 16GS steel produced by high temperature braze-welding. The single-layer steel specimens were cut from the three-layer composite material to assure identical testing conditions. The kinetics of absorbtion and liberation of hydrogen were studied using specimens of the composite material 6.7 mm thick and specimens of the single layer material (20YUCH steel) 3.8 mm thick. The single layer material was saturated with hydrogen throughout the time of hydrogenation. The barrier layer in the three-layer composite protected the main load-bearing layer from hydrogenation and facilitated creation of an equilibrium concentration of hydrogen in the surface layer of the 20YUCH steel turned toward the corrosive medium. References 4: all Russian.

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DEFORMATION RESISTANCE OF STEEL 45+U20KH6T2 IN WELDING BY ROLLING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 85
(manuscript received 21 Nov 84) pp 33-35

[Article by V. I. Kraynov, candidate of technical sciences, Chelyabinsk Polytechnical Institute, and I. A. Ryabtsev, candidate of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian SSR Academy of Sciences]

[Abstract] In order to determine the variation in strength properties of a bimetal as a function of the relationship of layer thicknesses and thermo-mechanical parameters of the rolling processes, the deformation resistance

of wear-resistant carbide steel type U20KH6T2 and a bimetallic product consisting of type 45 steel + U20KH6T2 was determined. Experiments were performed on a special CHPI-2 plastometer. An empirical equation was derived from the test results to calculate the deformation resistance of U20KH6T2 carbide steel as a function of the thermomechanical parameters of rolling, that it, the degree and rate of deformation and rolling temperature. The deformation resistance of the bimetal at 1000-1150°C changes in proportion to the fraction of the clad layer in the total thickness of a packet. References 4: all Russian.

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PLASMA WELDING OF 15KH25T STEEL IN A MIXTURE OF ARGON AND NITROGEN

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 85
(manuscript received 15 Nov 84) pp 53-55

[Article by K. A. Yushchenko, doctor of technical sciences, A. M. Ponizovtsev, candidate of technical sciences, deceased, A. A. Nakonechnyy and R. I. Morozova, engineers, Institute of Eledtric Welding imeni Ye. O. Paton, Ukrainian SSR Academy of Sciences]

[Abstract] Results are presented in this work from experiments performed within the framework of a search for the composition of welds with high activation energy of the recrystallization process and significant numbers of structural defects where impurity atoms may be concentrated and form isolated dispersed inclusions. The basis of the study was the principle of artificial introduction of elements with a tendency toward segregation so that impurities are separated not on the boundaries out rather in the bodies of the grains. The influence of the quantity of nitrogen in the protective mixture on mechanical properties of welded joints in type 15KH25T steel was estimated. Nitrogen content varied between 0 and 90%. The experiment showed that increasing the nitrogen content to over 80% results in the formation of pores in the weld. Nitrogen content and ductility are directly related. The impact toughness and bend angle of seams in pure argon are slight, fracture is brittle. Increasing nitrogen content increases both these quantities. References 10: Russian.

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NON-CONSUMABLE ELECTRODES FOR MELTING HIGHLY REACTIVE REFRACTORY METALS AND ALLOYS

Kiev PROBLEMY SPETSIAL'NOY ELEKTROMETALLURGII in Russian No 4, Oct-Nov-Dec 85 (manuscript received 6 Jun 84) pp 63-68

[Article by V. V. Stepanenko, Yu. V. Lisovoy and I. V. Sheyko, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] Development of modern science and technology constantly demands new materials that function at high temperatures, in corrosive media and under high tension. Therefore mastering the production of machine and instrument parts from highly-reactive refractory metals is very important. The present article examines non-consumable electrodes for electron-beam, plasma, induction and electric arc furnaces, the most widely-used means for the electric heating of highly-reactive refractory metals. The operation of so-called "hot" and "cold" electrodes is discussed. The best known of the latter are produced by the Schlinger and Westinghouse firms in the United States. The Schlinger "rotorod" has a fixed arc, with the electrode surface in motion, while the Westinghouse "durarc" variant has a moving electric arc in a magnetic field. The advantages and shortcomings of each are summarized. The Ye. O. Paton Electric Welding Institute has developed a non-consumable electrode which differs both in design and principle of operation. Operation of the electrode is described and its design diagrammed. The VT5L alloy produced with its use met all technical parameters, contained no more than 0.12% carbon, and had low loss of the Al alloying agent. It is suitable for producing highly reactive refractory metals and alloys in various electrometallurgical installations. References 12: 9 Russian, 3 Western (1 in Russian translation).

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